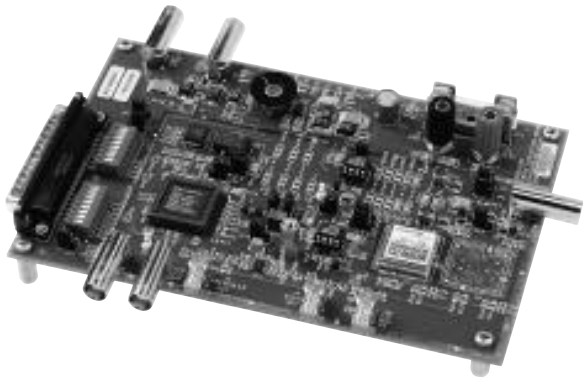
Q0420

PHASE-LOCKED OSCILLATOR (PLO) EVALUATION SYSTEM



USER'S GUIDE

INTRODUCTION

The Q0420 PLO Evaluation System is a complete evaluation board designed on a compact 5" x 7.5" printed circuit card for the Q3236 PLL. The evaluation platform includes a fixed demonstration as well as a custom prototyping design. A block diagram of the Q0420 is shown in Figure 1. The Q0420 demonstration platform consists of a phase-locked oscillator system which generates frequencies from 2 GHz to 3 GHz with a minimum step size of 5 MHz over the full output frequency range (÷ 2 prescaler included on-board). The custom prototyping option allows the designer to rapidly configure a custom synthesizer by adding a VCO, loop filter and reference suppression filter components to the alternative circuit sections of the board. The user can easily select between the demonstration platform and the custom prototyping design via on-board jumper options. Additional input and output connectors are also provided to easily support the use of off-board VCO's and prescalers to quickly evaluate the performance tradeoffs between alternative components.

The Q0420 can be computer controlled for remote operation, or alternatively controlled through the on-board frequency control switches for stand-alone operation. Remote operation is accomplished through the custom software program, Data I/O Card, and cabling provided with the Q0420 board. The menu-driven software will automatically compute all desired frequency programming and can exercise the following Q3236 modes of operation:

- 16-bit Direct Parallel Control
- 8-bit Data Bus Control
- 20-bit Serial Control
- 8-bit Data Ping-Pong Control
- 20-bit Serial Ping-Pong Control

Stand-alone operation with the Q0420 requires only a single +15VDC power supply, but can only utilize the Q3236's direct parallel interface for frequency programming using on-board DIP switches.

This User's Guide provides all the information needed to use the Q0420 PLO Evaluation System. Appendices are also provided which contain the Q0420 schematics, layout and a complete parts list. When designing custom synthesizers using the Q0420, it is recommended that the designer also read QUALCOMM's *Q3236 Technical Data Sheet*. It contains numerous design hints and discusses not only the electrical performance of the Q3236, but also has an application section that discusses how a PLL synthesizer can be designed.

The Q0420 PLO Evaluation System is meant to be a demonstration circuit and evaluation tool. QUALCOMM does not make any warranty as to the Q0420's suitability for a specific application without further design modifications. However, we believe you will find the Q0420 a useful system to further your understanding of synthesizer design with QUALCOMM's integrated PLL devices.

CONTENTS

1.0 GETTING STARTED 3
- 1.1 Digital I/O Board Installation 3
- 1.2 Digital I/O Board Software Configuration 3
- 1.3 Q0420 PLO Evaluation System Software Installation 5
- 1.4 Q0420 PLO Evaluation System Setup 6

2.0 SYNTHESIZER OPERATION 6
- 2.1 Inputs 6
  - 2.1.1 Power Supply Requirements 6
  - 2.1.2 External Reference Input; (J1) 6
  - 2.1.3 External VCO Input; (J10) 7
  - 2.1.4 Ping Pong Control In; (J10) 7
- 2.2 Outputs 7
  - 2.2.1 Synthesizer Out; (J9) 7
  - 2.2.2 Ref. Div. Out; (J2) 7
  - 2.2.3 VCO Div. Out; (J7) 7
  - 2.2.4 Prescaler Out; (J8) 7
  - 2.2.5 Ext. VCO Control; (J5) 7
- 2.3 Jumper Settings 8
  - 2.3.1 Reference Frequency Jumpers 8
  - 2.3.2 Loop Filters 9
  - 2.3.3 Op Amp Negative Rail Voltage Selection 9
  - 2.3.4 Reference Suppression Filter 10
  - 2.3.5 VCO Selection 10
  - 2.3.6 Prescaler 12
  - 2.3.7 Q3036 Mode 12
  - 2.3.8 Ping Pong Mode External Control 12
  - 2.3.9 Test Points 12

3.0 Q0420 FREQUENCY CONTROL 13
- 3.1 Direct Parallel Mode, Eight Bit Bus Mode, Serial Mode 14
  - 3.1.1 Reference Frequency 14
  - 3.1.2 Output Frequency 15
  - 3.1.3 Phase Detector Frequency 15
  - 3.1.4 Divide by Two Prescaler 15
  - 3.1.5 PRE EN/ 15
  - 3.1.6 Quit 15
- 3.2 Ping Pong Mode 16
  - 3.2.1 Output Frequency 17
- 3.3 DIP Switch Settings 17
  - 3.3.1 Reference Divider 18
  - 3.3.2 VCO Divider 18

4.0 DESCRIPTION OF BOARD FEATURES 20
- 4.1 Q3236 Phase-Locked Loop Frequency Synthesizer 20
- 4.2 Reference Oscillator 20
- 4.3 Line Receiver 20
- 4.4 Voltage Controlled Oscillator (VCO) 20
- 4.5 Loop Filter 20
- 4.6 Reference Suppression Filter 21
- 4.7 Prescaler 21

5.0 DESIGN HINTS AND SUGGESTIONS 22
- 5.1 Power Supplies 22
- 5.2 External Reference Source 22
- 5.3 Q0420 EMI Shield 22
- 5.4 Phase Offset Trimpot 22

6.0 RELATED LITERATURE 22

7.0 APPENDIX 23
- 7.1 Appendix A: Q0420 Schematic Drawings 24
- 7.2 Appendix B: Q0420 Parts List 30
- 7.3 Appendix C: Q0420 layout Drawings 32

QUALCOMM ASIC PRODUCTS 36

E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

Data Subject to ChangeWithout Notice

1.0 GETTING STARTED

The Q0420 PLO Evaluation System requires the following computer hardware as a minimum to operate in Remote Mode:

- PC 80386 or better
- 4 MB RAM
- Math Coprocessor
- Hard Drive
- Mouse
- Windows™ Version 3.1 or better
- SVGA Video Card (1024 X 768 resolution, small fonts)

The Q0420 PLO Evaluation System consists of a Q0420 Evaluation Board, Q0420 Shield, Q0420 Control Software, Control Cable, Digital I/O (DIO) Board, and DIO Board Installation Software. In order to operate the Q0420 Evaluation Board in Remote Mode, the DIO Board needs to be installed in a PC. The DIO Driver Software and the Q0420 Control Software needs to be installed on the hard drive of the PC. To use the Q0420 in Stand-alone Mode, a PC is not required.

Note: Windows™ is a trademark of Microsoft® Corporation.

1.1 DIGITAL I/O BOARD INSTALLATION

Install the DIO Board in any open slot in your PC according to the CIO-DIO24 User's Manual provided with the evaluation system. We recommend the base address of the CIO-DIO be set to 300H and the interrupt level set in the "X" position.

Once the DIO Board is installed in your PC, the board needs to be configured with the Instacal software provided. Place the Instacal disk in your floppy drive, access the floppy drive (usually A:) and type "Install". This can be accomplished in DOS or Windows.

1. The Computer Boards Software Installation title screen will appear once the Install.exe file is run. From this menu select "I", Install, to proceed and complete installation.

2. Once the PCMCIA installation window appears, select "No". Likewise, select "No" to the Universal Library and Labview Driver Installation Window.

3. Select the drive and directory you want the Instacal program to reside. We suggest using the default, C:\CB. The software will automatically copy all files from the disk into the specified directory on your hard drive.

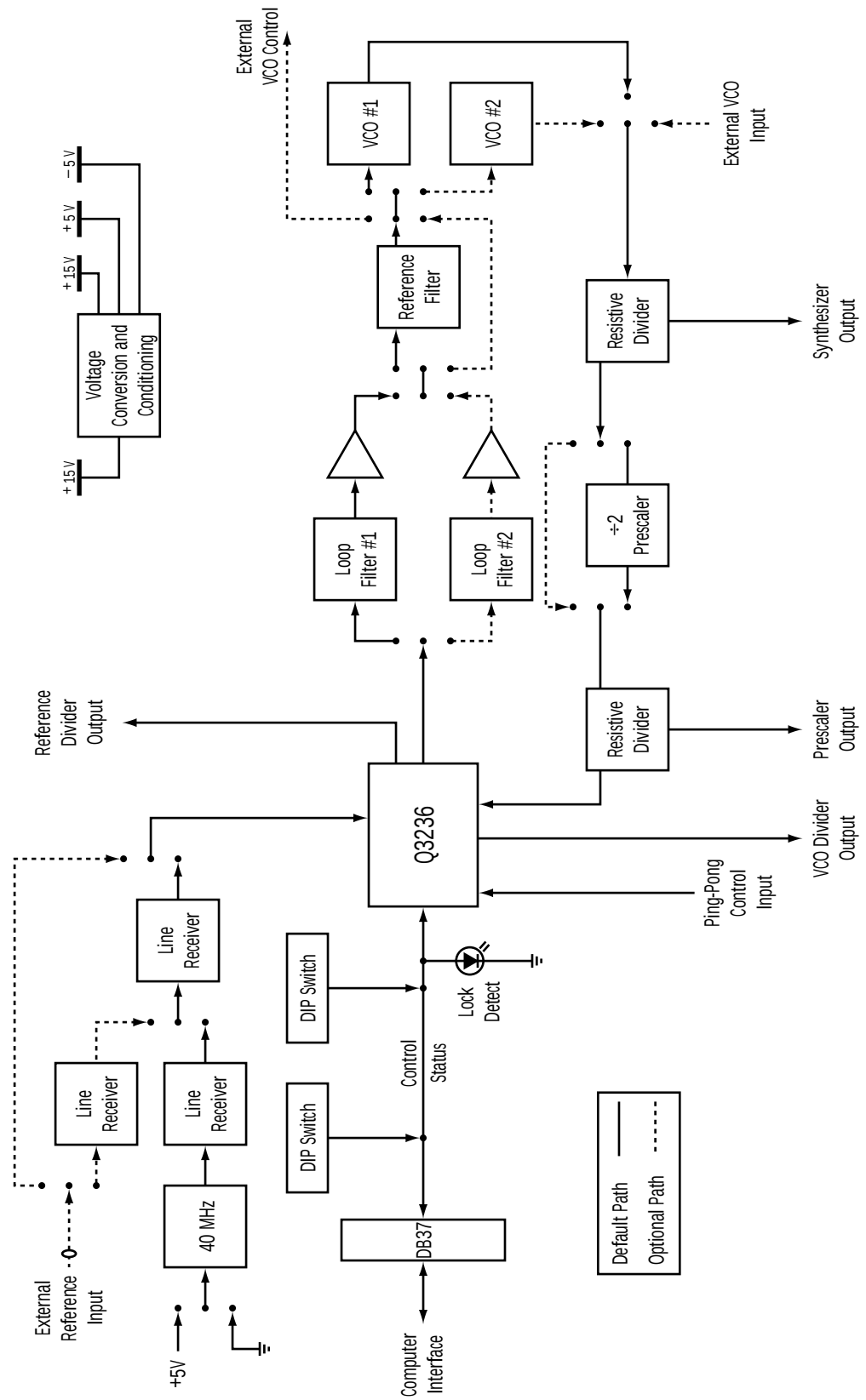
4. Once all files are copied to your hard drive, the software will ask if you would like to have the AUTOEXEC.BAT file modified automatically, select "Yes". The program will automatically add C:\CB to your path.

5. After all files have been copied to your hard drive, reboot your computer to complete the installation process.

1.2 DIGITAL I/O BOARD SOFTWARE CONFIGURATION

Once the software installation is complete, it is necessary to configure the software to control the Digital I/O board. The following procedure will configure and test the DIO drivers to ensure that the software is communicating with the DIO board.

Figure 1. Q0420 PLO Evaluation System Block Diagram



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

1. Once the software installation is complete, run Instacal.exe located in the drive and directory you chose during installation, most likely C:\CB.

2. From the Instacal Menu, double click your mouse on the “Install” pull down menu.

3. Double click your mouse on “Board #0”.

4. Select “Board type” and choose the “CIO-DIO24”.

5. Select the base address to match the address you selected via dip switches located on the CIO-DIO24 Board, most likely 300H.

6. Select the Interrupt Level to match the interrupt level you selected via the interrupt jumper located on the CIO-DIO24 Board, most likely none.

7. After the board is configured, it can be tested. To do this, double click your mouse on the “Test” pull down menu.

8. Select “Board #0 = CIO-DIO24”.

> WARNING
> BEFORE PROCEEDING TO THE NEXT STEP,
> REMOVE ALL EXTERNAL CONNECTIONS
> TO THE DIO BOARD

9. Select “Internal Test”, then “yes”.

10. The software will test the DIO Board checking the input and output registers. If the test is successful, you will receive a message that states “the DIO Board has been found and the registers have been written to and read back”. This completes the DIO installation process. If you receive an error message, recheck the jumper settings on the DIO Board and rerun the Instacal program Step 3 of Digital I/O Software Configuration. If you continue to receive an error message, contact Computer Boards Inc.

11. Exit from the Instacal program.

1.3 Q0420 PLO EVALUATION SYSTEM SOFTWARE INSTALLATION

The following procedure describes the Q0420 Control Software installation process.

1. Insert the Q0420 Control Software into the floppy drive of your computer.

2. Access the floppy drive using the Windows file manager.

3. Double click your mouse on “Setup.exe”.

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

4. The software will ask you where you want the files to be installed on your hard drive. The default is: C:\QUALCOMM\Q0420. The software will require approximately 3 MB of hard drive space. Select "Ok" to proceed. The software will copy and decompress all files onto your hard drive into the directory you selected.

5. Once all files have been written to your hard drive, the software will ask you if you want it to automatically create a Windows program group. The default program group name is "QUALCOMM". If you select "Create", the software will automatically create a program group and a program item for the Q0420 Control Software. If you select "skip", the software will not create the program group and program item.

6. This completes the Q0420 Control Software installation process. Select "Ok".

1.4 Q0420 PLO EVALUATION SYSTEM SETUP

First, turn off the computer; connecting the Q0420 Control Cable while the PC is on may damage the PC. Connect the DIO Board located in the PC to the Q0420 Evaluation Board through the DB37 Control Cable provided. Turn on PC and run Windows.

Before running the Q0420 Evaluation Board Software, ensure the dip switches S1 and S2 are set to the "off" or logical zero position. Operating the software while the dip switches are in the "1" or high position may damage the DIO Board. Execute the Q0420 Control Software from the QUALCOMM program group in Windows.

2.0 SYNTHESIZER OPERATION

Figure 1 shows the Q0420 PLO Evaluation System block diagram. The following paragraphs describe the function and operation of each of the circuit elements shown in the block diagram.

2.1 INPUTS

2.1.1 POWER SUPPLY REQUIREMENTS

A single +15 VDC ± 5% (500 mA capability) power supply is required to operate the Q0420. The +15VDC input is the red banana jack while ground is the black banana jack. The Q0420 converts and conditions the +15VDC input to +5VDC. A +15VDC to -5VDC voltage converter circuit is provided on the board for applications that require a negative rail be supplied to the op amp. The -5V regulation is a switching device and may cause spurious components on the output of the synthesizer. The -5V circuit is disabled when the board is shipped. Proper voltage input and conversion is indicated by the three yellow LED's, DS1-DS3.

2.1.2 EXTERNAL REFERENCE INPUT; (J1)

The External Reference Input allows the user to bypass the on-board 40 MHz reference oscillator. This input can be used to characterize the synthesizer output when using other reference sources. When the External Reference Input is used, the reference signal can be selected to be processed by the input line receiver or the reference signal can bypass the line receiver. Figure 2 illustrates the proper way to connect the on-board jumpers for various operating modes for the reference inputs. The nominal input to J1 is 0 to 100 MHz, -10 to +5 dBm for a 50 ohm source. If you choose to use an external reference, the power to the 40 MHz on-board reference should be disabled to minimize on-board oscillations.

2.1.3 EXTERNAL VCO INPUT; (J10)

The External VCO Input is provided as a means to input a signal directly into the differential VCO inputs to the Q3236. This is necessary when using an external VCO or for troubleshooting the synthesizer system. The nominal input to J10 is -10 dBm to +3 dBm.

2.1.4 PING PONG CONTROL IN; (J10)

The Ping Pong Control Input is only used when operating the Q3236 in the Ping Pong Mode. The input is routed to either FSELS or FSELP depending on the jumper position of JP16 and resistors R87 and R88. This input allows an external CMOS compatible input to switch between the data in the primary registers and the secondary registers. When FSELS/FSELP is high, the synthesizer output frequency is obtained from the frequency word stored in the primary registers. Conversely, when FSELS/FSELP is low, the synthesizer output frequency is obtained from the frequency stored in the secondary registers. This input is ideal for creating a FSK modulator for slow data rates.

2.2 OUTPUTS

2.2.1 SYNTHESIZER OUT; (J9)

The Synthesizer Out signal provides the 2000 - 3000 MHz output in 5.0 MHz steps when using the on-board 40 MHz reference and VCO. The output power ranges from 0 to +7 dBm.

2.2.2 REF. DIV. OUT; (J2)

The Ref. Div. Out provides a test point to view the divided Input Reference signal to the Phase/Frequency Detector on the Q3236. This output can also be used along with the VCO Div. Out to drive an external Phase/ Frequency detector or other external circuitry, if desired. Refer to the *Q3236 Technical Data Sheet* for nominal output levels.

2.2.3 VCO DIV. OUT; (J7)

The VCO Div. Out provides a test point to view the divided VCO input signal that is being input to the Phase/ Frequency Detector. This output can also be used along with Ref. Div. Out to drive an external Phase/Frequency detector or other external circuitry, if desired. Refer to the *Q3236 Technical Data Sheet* for nominal output levels.

2.2.4 PRESCALER OUT; (J8)

The Prescaler Out provides a test point to view the VCO divide-by-two prescaler output signal, which is also routed to the Q3236 VCO input. The output power of this signal is -25 dBm ± 3 dBm.

2.2.5 EXT. VCO CONTROL; (J5)

The Ext. VCO Control is provided for use with an external VCO. The Ext. VCO Control provides the tuning voltage to the external VCO. The external VCO output can be fed back to the PLL device via Ext. VCO Input. By using an external VCO, the Q0420 can generate frequencies from L-Band to Ku-Band or higher. When output frequencies exceed 3000 MHz, an external prescaler is necessary prior to the Ext. VCO Input.

2.3 JUMPER SETTINGS

The Q0420 Evaluation Board has several jumpers which allow the option of choosing multiple configurations. The evaluation board is shipped with jumpers in default positions. The default jumper positions are listed in Table 1.

Table 1. Default Jumper Positions

JUMPER	POSITION	JUMPER	POSITION	JUMPER	POSITION	JUMPER	POSITION
JP1	1 and 2	JP5	1 and 2	JP9	1 and 2	JP13	2 and 3
JP2	2 and 3	JP6	1 and 2	JP10	1 and 2	JP14	1 and 2
JP3	2 and 3	JP7	2 and 3	JP11	1 and 2	JP15	1 and 2
JP4	1 and 2	JP8	2 and 3	JP12	1 and 2	JP16	1 and 2

2.3.1 REFERENCE FREQUENCY JUMPERS

There are three possible configurations for the reference jumpers, see Figure 2 and Table 2. We suggest using the line receiver for frequencies under 40 MHz.

Configuration 1: Use the 40 MHz on-board reference. Use the supplied bi-pin jumpers and connect JP6 pin 1 and 2, JP2 pin 2 and 3, JP8 pin 2 and 3.

Configuration 2: Use the Ext. Ref. Input and select the line receiver. Use the supplied bi-pin jumpers and connect JP1 pin 2 and 3, JP2 pin 1 and 2, JP8 pin 2 and 3. When not using the on-board reference, connect JP16 pin 2 and 3. This will power-down the on-board 40 MHz reference and decrease extraneous signal generation.

Configuration 3: Use the Ext. Ref. Input and bypass the line receivers. Use the supplied bi-jumpers and connect JP1 pin 1 and 2, JP8 pin 1 and 2. When not using the on-board reference, connect JP6 pin 2 and 3. This will power-down the on-board 40 MHz reference and decrease extraneous signal generation.

Figure 2. Reference Jumpers

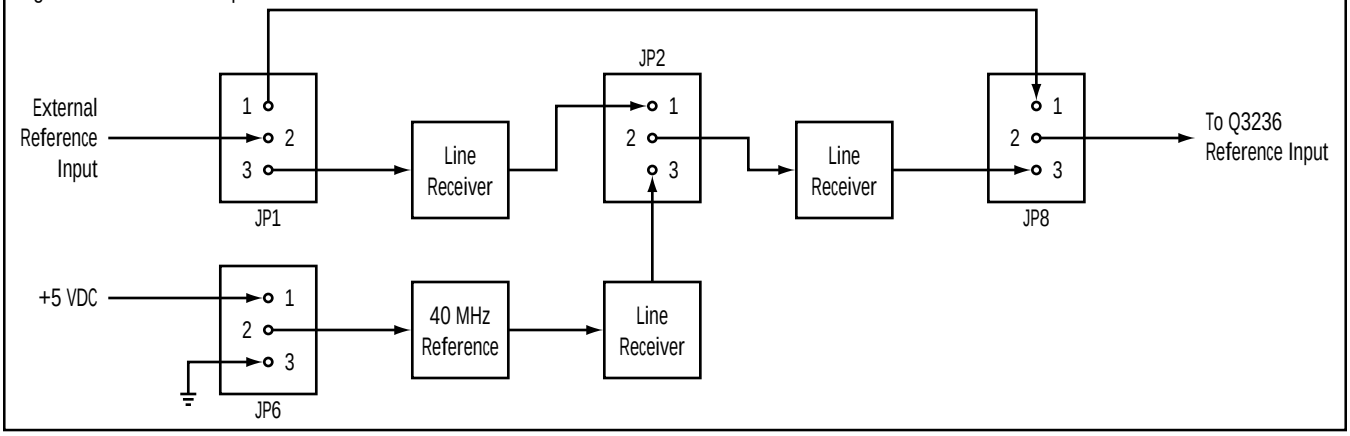


Table 2. Reference Selection

REFERENCE SELECTION	JP6	JP1	JP2	JP8
On Board Reference	1,2	–	2,3	2,3
External Reference with Line Receiver	2,3	2,3	1,2	2,3
External Reference without Line Receiver	2,3	1,2	–	1,2

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
Q0420 Phase-Locked Oscillator (PLO) Evaluation System
User's Guide
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556
Data Subject to ChangeWithout Notice

2.3.2 LOOP FILTERS

Two loop filters are provided on the Q0420 Evaluation Board. The first loop filter is a second order filter which is populated and optimized for 100 kHz closed loop bandwidth for frequency operation between 2000 - 3000 MHz. The second loop filter can be configured as a second order or third order loop filter. This loop is not populated and is provided to the user for prototyping purposes. In order to select the first loop filter, connect jumpers JP10 pin 1 and 2, JP11 pin 1 and 2, and JP14 pin 1 and 2. In order to select the second unpopulated loop filter, connect jumpers JP10 pin 2 and 3, JP11 pin 2 and 3, and JP14 pin 2 and 3. See Figure 3 and Table 3.

Figure 3. Loop Filter Selection Jumpers

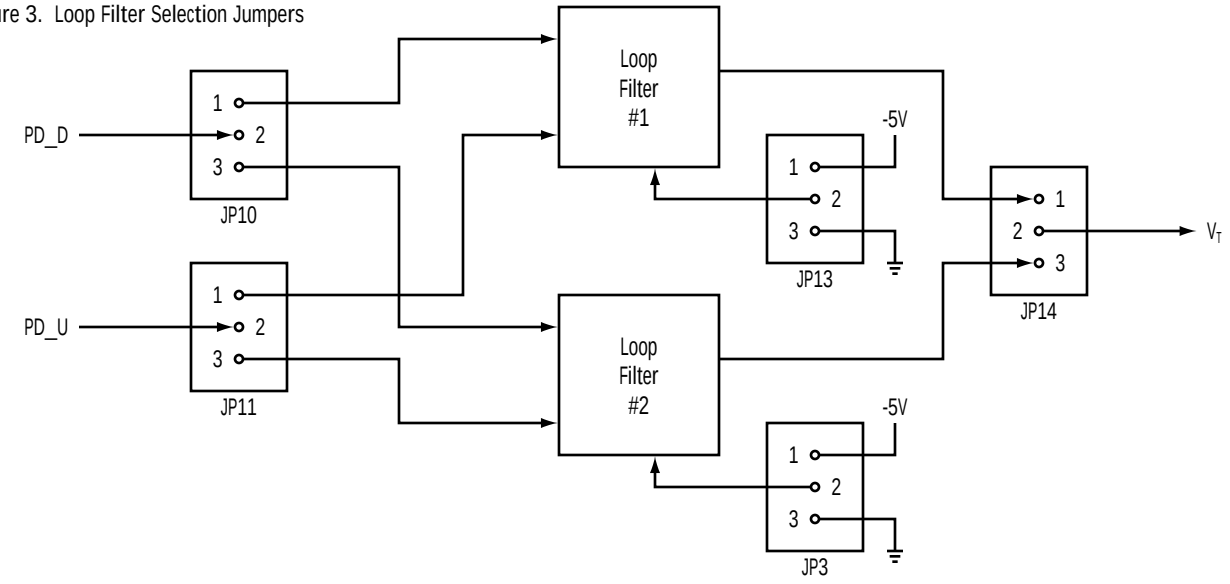


Table 3. Loop Filter Select

LOOP FILTER SELECT	JP10	JP11	JP14
Loop #1	1,2	1,2	1,2
Loop #2	2,3	2,3	2,3

2.3.3 OP AMP NEGATIVE RAIL VOLTAGE SELECTION

The negative rail of the LT1357 OP Amp can be set to either ground or -5 volts. In order to set the negative rail of the op amp to -5 volts on the first loop filter, connect JP13 pins 1 and 2. To set the negative rail to ground, connect pins 2 and 3. Connect JP3 pins 1 and 2 to select -5 volts on the second loop filter or pins 2 and 3 for ground. See Figure 3, Table 4 and Table 5.

Table 4. Negative OP Amp Rail Selection Loop #1

NEGATIVE RAIL SELECTION LOOP #1	JP13
-5V	1,2
GND	2,3

Table 5. Negative OP Amp Rail Selection Loop #2

NEGATIVE RAIL SELECTION LOOP #2	JP3
-5V	1,2
GND	2,3

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

2.3.4 REFERENCE SUPPRESSION FILTER

A reference suppression filter is provided on the board to attenuate the phase/frequency detector error pulses at the rate FPD. The reference suppression filter was optimized for 2.5 MHz and may need to be redesigned for different phase detector frequencies. In order to use the reference suppression filter, connect JP15 pins 1 and 2, and JP4 pins 1 and 2. If the user does not want to utilize the filter, connect JP15 pins 2 and 3, and JP4 pins 2 and 3. See Figure 4 and Table 6.

Figure 4. Reference Suppression Filter Jumpers

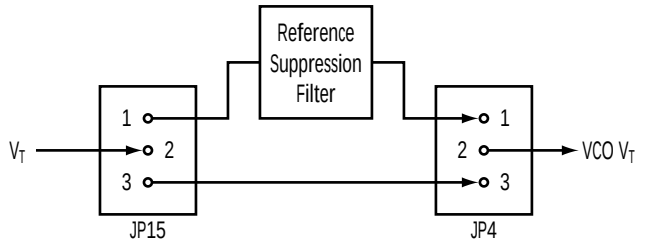


Table 6. Reference Filter Select

REFERENCE FILTER SELECT	JP15	JP4
IN	1,2	1,2
Bypass	2,3	2,3

2.3.5 VCO SELECTION

The evaluation board can accommodate two VCO's or utilize an external VCO. The board is shipped with a 2000 -3000 MHz VCO, U7, already installed. The user can install a different VCO, U8, or route the tune voltage off the evaluation board to an external VCO. Once the VCO is properly installed, the voltage tune path and the VCO output path needs to be configured. Figure 5, Table 7 and Table 8 show the VCO voltage tune paths and the VCO RF output paths.

Figure 5. VCO Selection Jumpers

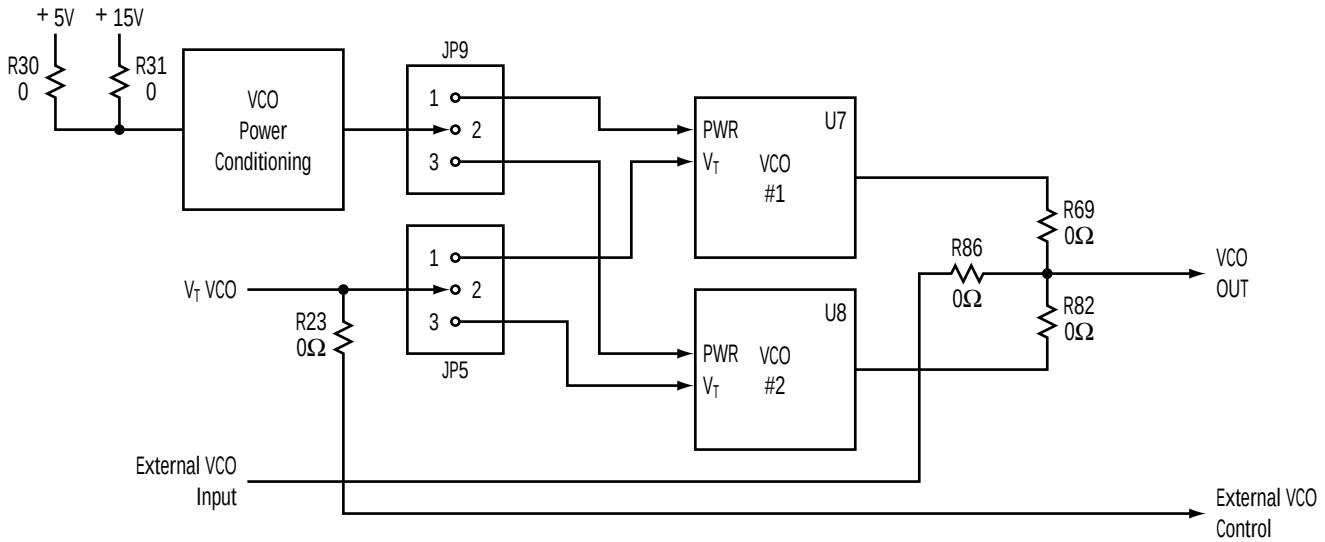


Table 7. VCO Select

VCO SELECT	JP5	R23	R69	R86	R82
VCO #1	1,2	OUT	IN	OUT	OUT
VCO #2	2,3	OUT	OUT	OUT	IN
External VCO	Open	IN	OUT	IN	OUT

Table 8. VCO Power

VCO POWER	R30	R31	JP9
+ 5 V	IN	OUT	–
+ 15 V	OUT	IN	–
VCO #1	–	–	1,2
VCO #2	–	–	2,3

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

Configuration 1: Default VCO, U7. Connect JP5 pins 1 and 2 to route the tune voltage to the default VCO. R23, the zero ohm resistor, should be removed for optimum performance. Install R69, a zero ohm resistor, and remove R82 and R86 to select the correct RF output path.

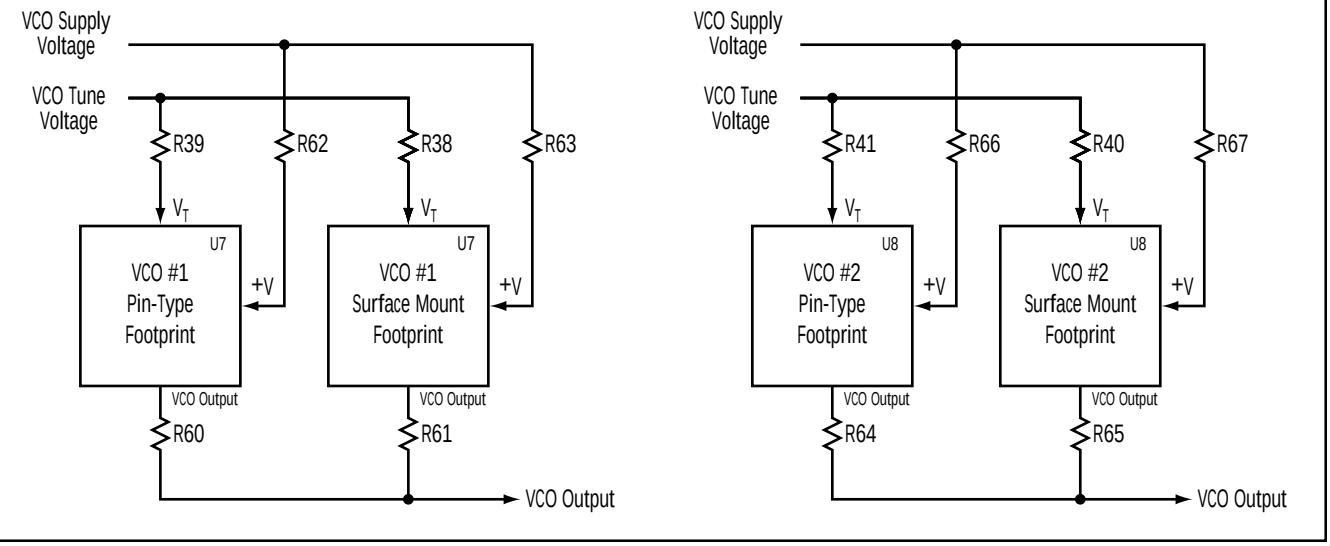
Configuration 2: Second VCO, U8. Connect JP5 pins 2 and 3 to route the tune voltage to the second VCO, U8. R23, the zero ohm resistor, should be removed for optimum performance. Install R82, a zero ohm resistor, and remove R69 and R86 to select the correct RF output path. Also, an AC coupling capacitor, C95, needs to be installed. This capacitor is not provided. The capacitor value selected should be optimized for the frequency output of the VCO.

Configuration 3: External VCO. Remove the jumper on JP6 and install a zero ohm resistor in R23 to route the tune voltage to an external VCO. The external VCO tune voltage will be present on J5, a BNC connector. Install R86, a zero ohm resistor, and remove R69 and R82. Also, an AC coupling capacitor, C94, needs to be installed. This capacitor is not provided. The capacitor value selected should be optimized for the frequency output of the VCO.

Fifteen volts or five volts can be routed to the power pin of either VCO depending on the operating voltage of the user's VCO. Installing R31, a zero Ohm resistor, routes +15 volts to jumper J9. When R30 is installed, +5V is routed to J9. See Table 8. CAUTION: R30 and R31 cannot be installed at the same time. Damage may occur to the board if this happens.

As stated above, the Q0420 can accommodate two VCO's. Each VCO pad can accept two types of VCO footprints, either a standard 0.81" square pin-type package or a standard 0.91" square surface mount package. In order to accommodate the two VCO footprints, the tune voltage, supply voltage and VCO output are routed through 0Ω resistors. The Q0420 is manufactured with the resistors configured for the pin-type VCO's. If the user would like to use a surface mount VCO footprint, the 0Ω resistors need to be configured according to Figure 6.

Figure 6. VCO Pad Configuration



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

2.3.6 PRESCALER

A divide-by-two prescaler is provided in the VCO feedback path on the evaluation board as shown in Figure 7 and Table 9. This allows the Q3236 to synthesize frequencies above 2.0 GHz. The prescaler can be used in the feedback path to the Q3236 or it can be bypassed. Install zero ohm resistors in R78 and R75, and remove resistors R85 and R84 to utilize the prescaler. In order to bypass the prescaler, remove resistors R78 and R75, and install zero ohm resistors in R85 and R84.

Figure 7. Prescaler Select Jumpers

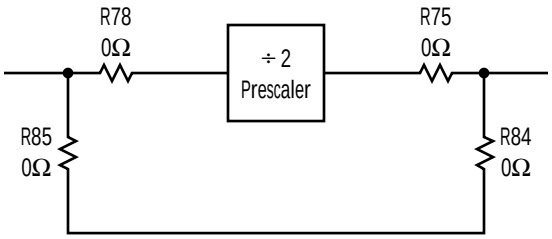


Table 9. Prescaler Select

÷2 PRESCALER SELECT	R78	R75	R85	R84
IN	IN	IN	OUT	OUT
Bypass	OUT	OUT	IN	IN

Table 10. Mode Select

MODE SELECT JUMPERS	JP7 Connection
Enhanced Mode (Access to M7, M8, R4, R5)	Pins 1 and 2
Q3036 Mode/	Pins 2 and 3

2.3.7 Q3036 MODE

The Q3236 is pin-for-pin compatible with the Q3036 PLL and can be used as a direct replacement. Pin 44 of the Q3236 must be pulled “low” to operate in the Q3036 mode. Connect pins 2 and 3 of JP7 to pull pin 44 “low”. To use the Q3236 in Normal Mode and have access to the upper M and A counter bits, connect JP7 pins 1 and 2, which pulls pin 44 “high”, see Table 10.

2.3.8 PING PONG MODE EXTERNAL CONTROL

When operating the Q0420 in Ping Pong Mode, the output frequency register selected can be controlled either through the control software or through the external Ping Pong Control In, Connector J6. If you are using the software to control which frequency register is selected, then the Q0420 does not need to be modified. To use the External Ping Pong Control Input to control frequency selection, then board modifications are required. If using Eight Bit Bus Ping Pong Mode, connect pins 2 and 3 of J16 and remove R88. This will route the input on J6 to the FSELP pin on the Q3236 and will disable the software from controlling the FSELP pin. If using Serial Bus Ping Pong Mode, connect pins 1 and 2 of JP16 and remove R87. This will route the input of J6 to the FSELS pin on the Q3236 and will disable the software from controlling the FSELS pin.

2.3.9 TEST POINTS

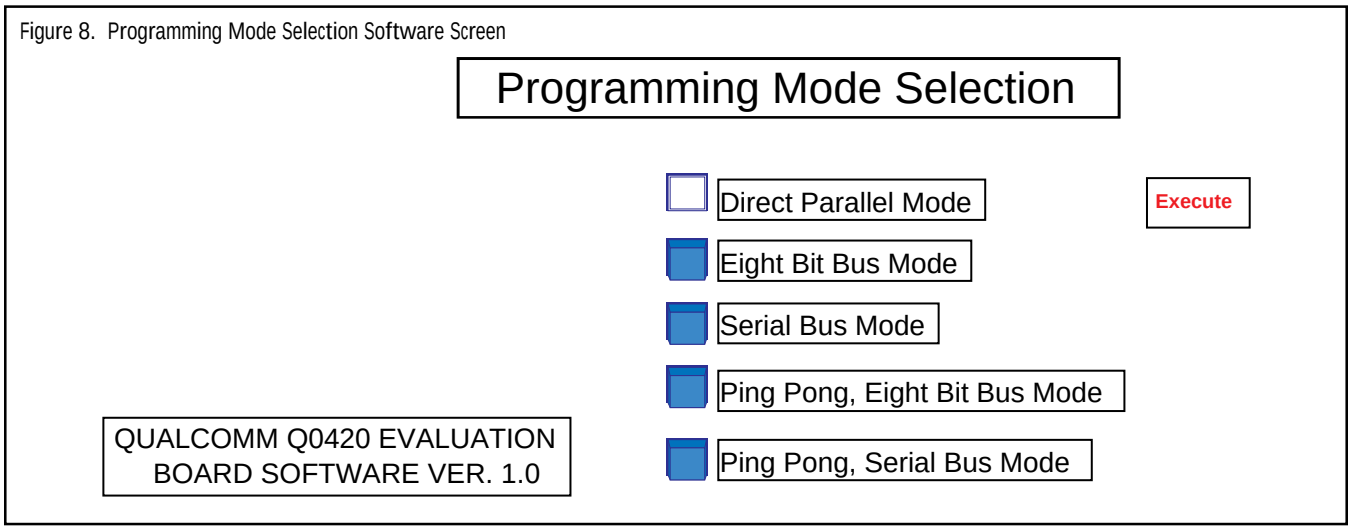
Test points are located throughout the evaluation board for your convenience during testing and evaluation. Refer to the schematic in Appendix A for test points.

3.0 Q0420 FREQUENCY CONTROL

The frequency of the Q0420 can either be controlled through software and the Digital I/O Board or by setting the DIP Switches. The software that is provided with the Q0420 Evaluation Board allows the user to program the Q3236 in each of the five programming modes: Direct Parallel, Eight Bit Bus, Serial Bus, Ping Pong Eight Bit Bus, Ping Pong Serial Bus. The control software calculates the value of the M,A, and R counters and programs the Q3236.

Before executing the Q0420 Control Software, make sure all DIP switches S1 and S2 are set to "0". From Windows, double click on the Q0420 Control Software icon to execute the software. The window shown in Figure 8 will appear. If this window or subsequent windows do not fit on your monitor, then your video driver needs to be changed. For optimum performance, choose a video driver that supports a resolution of 1024 by 768 and at least 256 colors. You may move or resize the window as required. Choose the method in which you want to program the Q3236 by selecting the programming method and then selecting the execute button. One of five programming windows will appear. The window for Direct Parallel Mode, Eight Bit Bus Mode, and Serial Mode look the same but the programming of the Q3236 is carried out differently. Likewise, the Ping Pong Eight Bit Bus Mode and the Ping Pong Serial Mode front panels look the same but the programming of the Q3236 is carried out differently.

Figure 8. Programming Mode Selection Software Screen


Programming Mode Selection
Direct Parallel Mode
Eight Bit Bus Mode
Serial Bus Mode
Ping Pong, Eight Bit Bus Mode
Ping Pong, Serial Bus Mode
Execute
QUALCOMM Q0420 EVALUATION BOARD SOFTWARE VER. 1.0

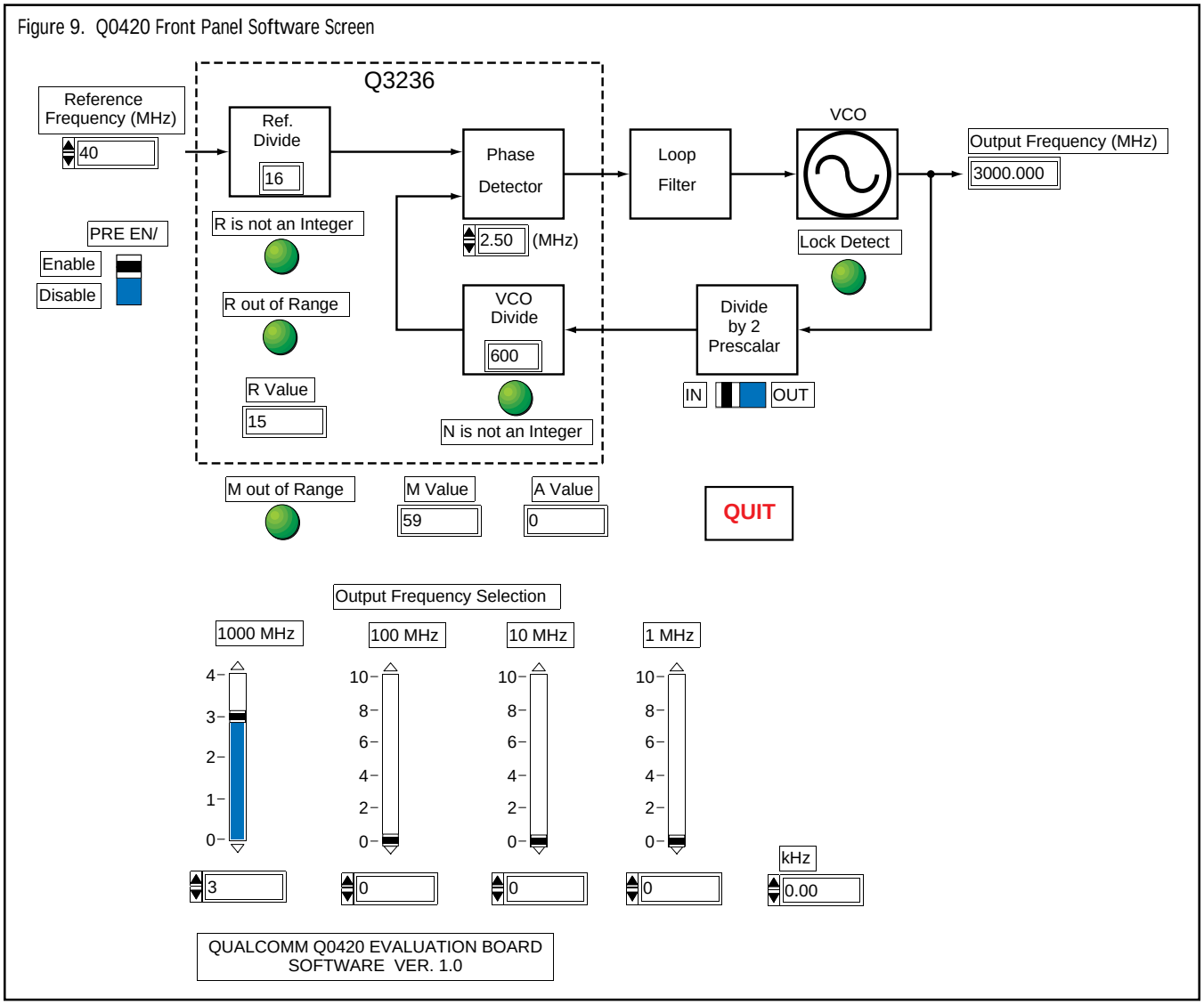
QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

3.1 DIRECT PARALLEL MODE, EIGHT BIT BUS MODE, SERIAL MODE

When either Direct Parallel Mode, Eight Bit Bus Mode, or Serial Bus Mode is selected from the Programming Mode Selection Menu (Figure 8), the window shown in Figure 9 will appear. The software will ask you if you want to go through the jumper setting windows. If you are a first time user of the evaluation board, it is suggested that you go through the jumper setting windows. You may also choose to bypass the jumper setting windows.

The programming window shown in Figure 9 represents a block diagram of a phase-locked loop. The user has control of the Reference Frequency, Output Frequency, Phase Detector Frequency, Divide-by-Two Prescaler, PRE EN/ and QUIT. The Reference Divide, VCO Divide, R Value, M Value, A Value, R is not an Integer, R out of Range, and N is not an Integer are calculated from the inputs selected by the user. These values are then programmed into the Q3236 automatically. The lock detect LED monitors pin 43 of the Q3236 and indicates if the synthesizer is locked.

Figure 9. Q0420 Front Panel Software Screen



3.1.1 REFERENCE FREQUENCY

The reference frequency can be changed to match the frequency being supplied to the Q3236. The Q0420 Board is supplied with a 40 MHz reference crystal oscillator; therefore, the default is set to 40 MHz. Changing this icon does not change the frequency supplied to the Q3236; it only aids in calculating the R value. If the value of R is

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

not an integer based on the reference frequency and the frequency of the phase detector, (R=Reference/FPD -1), the R is not an Integer LED will illuminate red. Conversely, if the value of R is an integer, the LED will illuminate green. If the value of R exceeds the number of R counter bits, the R Out of Range LED will illuminate red. If the value of R is in range, the LED will illuminate green. The R Out of Range Condition is calculated differently depending on the programming mode. Refer to the Q3236 Specifications for the different ranges of R.

3.1.2 OUTPUT FREQUENCY

The output frequency of the VCO is selected from the four slides and the number of kHz selected. The sum of the slides is displayed next to the VCO block. The slides can be changed to move the VCO in course steps or fine steps. The resultant VCO divide value is shown in the VCO Divide Block. The N is Not an Integer LED will illuminate red if the VCO divide value is not an integer based upon the desired output frequency, the frequency of the phase detector, (N=VCO Frequency/Frequency of the Phase Detector), the state of the Divide-by-Two Prescaler Switch, and PRE EN/. If N is an integer, the LED will illuminate green. The M and A values are calculated based upon the value of the VCO Divide and are displayed below the block diagram. The software calculates if M is within range of the M counter bits available, depending on the programming mode. If M is within range, the M in Range LED will illuminate green; if M is out of range, the LED will be red. The Q0420 Evaluation Board was designed to generate output frequencies from 2.0 to 3.0 GHz in 5 MHz steps.

3.1.3 PHASE DETECTOR FREQUENCY

The phase detector frequency, synthesizer step size, is chosen from the control located under the Phase Detector Frequency block of the block diagram. The phase detector frequency can be as large as 100 MHz or small as desired as long as the values of R and M are within range. The Q0420 Evaluation Board was designed with a default value of 2.5 MHz phase detector frequency.

3.1.4 DIVIDE-BY-TWO PRESCALER

An external divide-by-two prescaler is provided on the evaluation board for output frequency operation up to 3.0 GHz. If using the prescaler in the output frequency feedback path, the switch should be placed in the “IN” position. The software automatically calculates the M and A values based upon the divide-by-two prescaler in the feedback path. If not using the prescaler in the feedback path, the position should be switched to the “OUT” position. When the prescaler is not used, the maximum frequency of the PLL is 2.0 GHz.

3.1.5 PRE EN/

The PRE EN/ switch selects the internal mode of operation of the Q3236. When the PRE EN/ is enabled, the PRE EN/ value is “low” or zero volts. In this mode, frequency division is accomplished with a pulse-swallow counter made up of the 10/11 front-end dual modulus prescaler. In this mode, frequency division up to 3.0 GHz on the Q0420 Evaluation Board is possible.

When the PRE EN/ switch is disabled, the Q3236 internal prescaler is bypassed so that the VCO input frequency is divided by the M counter and the A counter is ignored. The M counter operates at frequencies up to 300 MHz. In this mode, frequency division ratios are continuous from 1 to 511.

3.1.6 QUIT

When the Quit button is selected, the current programming mode is exited and the Programming Mode Selection Window is displayed.

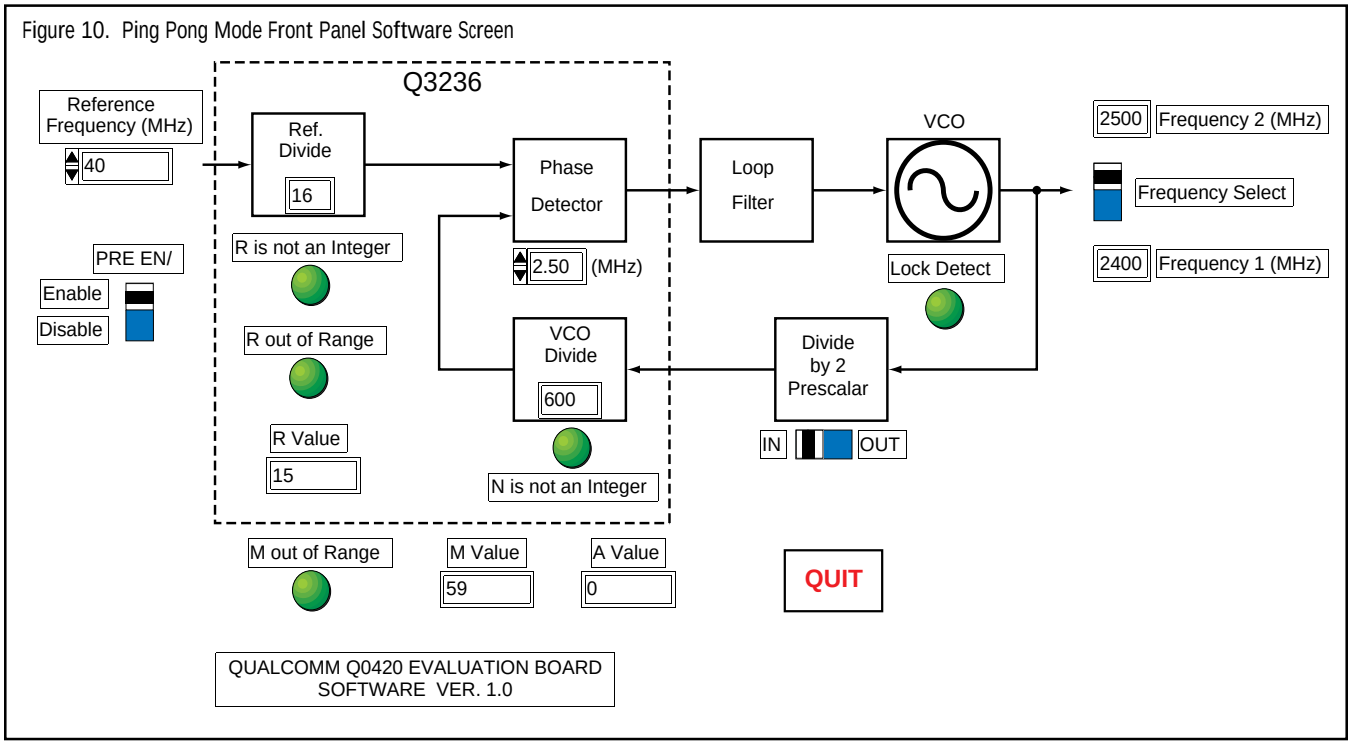
3.2 PING PONG MODE

When either Ping Pong Eight Bit Bus Mode or Ping Pong Serial Bus Mode is selected from the Programming Mode Selection Menu (Figure 8) the window shown in Figure 10 will appear. The software will ask you if you want to go through the jumper setting windows. If you are a first time user of the evaluation board, it is suggested that you go through the jumper setting windows. You may also choose to bypass the jumper setting windows.

The programming window shown in Figure 10 represents a block diagram of a phase-locked loop. The user has control of the Reference Frequency, Output Frequency, Phase Detector Frequency, Divide-by-Two Prescaler, PRE EN/ and QUIT. The Reference Divide, VCO Divide, R Value, M Value, A Value, R is not an integer, R out of range, and N is not an integer is calculated from the inputs selected by the user. The lock detect LED monitors pin 43 of the Q3236 and indicates if the synthesizer is locked.

All control features are the same as previously described, except for the output frequency control.

Figure 10. Ping Pong Mode Front Panel Software Screen



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
Q0420 Phase-Locked Oscillator (PLO) Evaluation System
User's Guide

E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556
Data Subject to ChangeWithout Notice

3.2.1 OUTPUT FREQUENCY

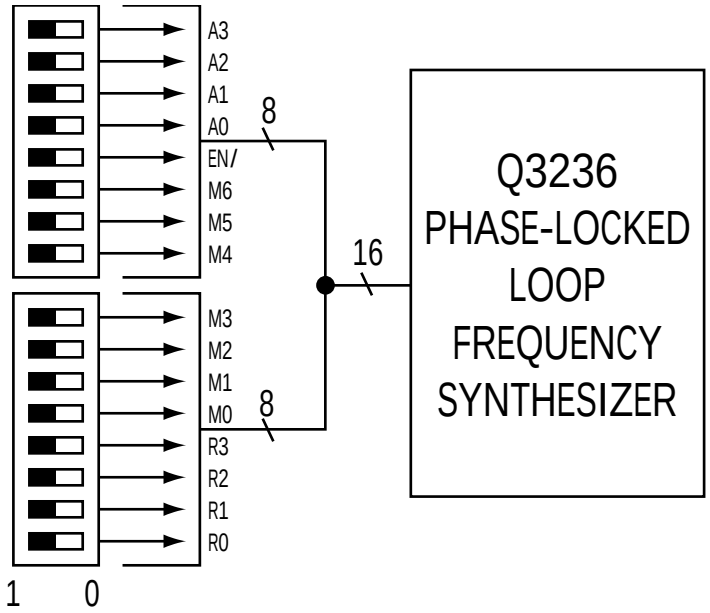
In Ping Pong Mode, two frequencies are programmed on the front panel (Figure 10) and the output frequency is selected from the Frequency Select Switch. These two frequencies are programmed in Q3236 primary and secondary registers. When the switch is down, the phase-locked loop will lock at the frequency displayed in the Frequency One box and the associated values of VCO Divide, M, and A are displayed. When the switch is up, the phase-locked loop will lock at the frequency displayed in the Frequency Two box and the associated values of VCO Divide, M, and A are displayed. If the VCO Divide value is not an integer based upon the desired output frequency, the frequency of the phase detector, the state of the Divide-by-Two Prescaler Switch, and PRE EN/, the N is Not an Integer LED will illuminate red. If N is an integer, the LED will illuminate green. The M and A values are calculated based upon the value of the VCO Divide and are displayed below the block diagram. The software calculates if M is within range, depending on the programming mode. If M is within range, the M in Range LED will illuminate green; if M is out of range, the LED will be red.

3.3 DIP SWITCH SETTINGS

The Q0420 can also be operated without the control software and programmed directly through the dip switches located on the evaluation board. Remove the Q0420 Programming Cable before operating the board through the DIP switches. In order to operate the Q0420 Evaluation Board in Direct Parallel Mode, connect JP7 pins 2 and 3. This will pull pin 44, /Q3036 Mode, "low" and pin 22, Busmode/ will float "high", thus configuring the Q3236 to operate in Direct Parallel Mode. In this mode, the upper M counter bits M7, M8 and the upper R counter bits R4 and R5 are not available.

The Q0420 has two DIP style 8-position switches (S1 and S2) that provide the R, M, A and PRE EN/ control inputs to the Q3236 (Figure 11). The inputs control the division moduli for the REFERENCE (R0-R3) and VCO Dividers (M0-M6 and A0-A3) as well as the selection of the PRESCALER or NONPRESCALER Modes (PRE EN/). The following paragraphs describe how to program S1 and S2.

Figure 11. DIP Switch Control



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

3.3.1 REFERENCE DIVIDER

The QUALCOMM Q3236 has an on-chip Reference Divider. The divider is a 4-bit counter and will divide the reference input by 1-16 in unit steps; this corresponds to the Q3236 functioning in "Q3036 Mode" (Refer to *Q3236 Technical Data Sheet*). For the Reference Divider to divide the 40 MHz reference to 2.50 MHz, it must be programmed with a divide ratio of 16. The procedure for computing the binary values of R0, R1, R2 and R3 are as follows:

$R = (F_{REF} + F_{PD}) - 1$

$R = (F_{REF} + F_{PD}) - 1 = (40\ MHz \div 2.5\ MHz) - 1 = 15$ (decimal) = 1111 (binary)

R0, R1, R2, R3 = high (switches "1")

3.3.2 VCO DIVIDER

When using the Prescaler Mode, the VCO Divider has the capability of dividing the VCO input by values ranging from 90-1295 in unit steps. For the Q0420 to synthesize the output frequency range of 2000 MHz to 3000 MHz using the FPD of 2.50 MHz, the VCO Divider must be programmed through the moduli range of 400 to 600. The Q0420 provides a ÷2 prescaler in the VCO frequency feed back path to the Q3236, which allows the Q3236 to synthesize frequencies greater than 2000 MHz. The ÷2 prescaler divides the VCO output frequency by two, thus the Q3236 only sees frequencies from 1000 MHz to 1500 MHz. The following section describes the procedure for programming the M and A control inputs to the QUALCOMM PLLFS.

To program the Q0420 PLO Evaluation System to output F_{VCO} = 2500 MHz, the total divide ratio is:

$N = F_{VCO} \div F_{PD} \div$ External Prescaler = 2500 MHz ÷ 2.5 MHz ÷ 2 = 500.

The binary values for M and A are computed as follows:

M = Integer {N÷10} - 1 = Integer {500 ÷ 10} - 1 = 49 decimal = 0110001 binary

M0, M4, M5 = high (switches "1")

M1, M2, M3, M6 = low (switches "0")

A = N - {10(M+1)} = 500 - {10(49 + 1)} = 0 decimal = 0000 binary

A0-A3 = low (switches "0")

Since the output frequency of the synthesizer board is above 300 MHz, the VCO Divider is programmed to the Prescaler Mode which is selected by setting PRE EN/ to low (switches "0").

The above information is then used to program S1 and S2. S1 and S2 are programmed by setting the respective switch to the "0" position to set the control input to a low and to the "1" position to set the control input to a high.

To program the Q0420 PLO Evaluation System to output FVCO = 2000 MHz, the total divide ratio is:

$N = F_{VCO} \div F_{PD} \div$ Prescaler = 2000 MHz ÷ 2.5 ÷ 2 = 400

M = Integer {N ÷ 10} - 1 = Integer {400 ÷ 10} - 1 = 39 decimal = 0100111 binary

M0, M1, M2, M5 = high (switch "1")

M3, M4, M6 = low (switch "0")

A = N - {10(M + 1)} = 400 - {10(39 + 1)} = 0 decimal = 0000 binary

A0, A1, A2, A3 = low (switch "0")

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

This same procedure can be followed to program the Q0420 PLO Evaluation System to output any frequency in the range of 2000 - 3000 MHz in 5.0 MHz steps. Table 11 shows the correct switch settings in 100 MHz increments.

Table 11. Output Frequency Switches

Synthesizer Output Freq. (J1)	Ref. Divider R Counter	VCO M Counter	Divider A Counter	Synthesizer Output Freq. (J1)	Ref. Divider R Counter	VCO M Counter	Divider A Counter
2000 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 1 M2 = 1 M3 = 0 M4 = 0 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0	2600 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 1 M2 = 0 M3 = 0 M4 = 1 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0
2100 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 0 M2 = 0 M3 = 1 M4 = 0 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0	2700 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 0 M2 = 1 M3 = 0 M4 = 1 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0
2200 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 1 M2 = 0 M3 = 1 M4 = 0 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0	2800 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 1 M2 = 1 M3 = 0 M4 = 1 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0
2300 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 0 M2 = 1 M3 = 1 M4 = 0 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0	2900 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 0 M2 = 0 M3 = 1 M4 = 1 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0
2400 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 1 M2 = 1 M3 = 1 M4 = 0 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0	3000 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 1 M2 = 0 M3 = 1 M4 = 1 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0
2500 MHz	R0 = 1 R1 = 1 R2 = 1 R3 = 1	M0 = 1 M1 = 0 M2 = 0 M3 = 0 M4 = 1 M5 = 1 M6 = 0	A0 = 0 A1 = 0 A2 = 0 A3 = 0				

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

4.0 DESCRIPTION OF BOARD FEATURES

4.1 Q3236 PHASE-LOCKED LOOP FREQUENCY SYNTHESIZER

Please refer to the *Q3236 Technical Data Sheet* for details and features of this integrated PLL device.

4.2 REFERENCE OSCILLATOR

The Q0420's on-board reference is a 40 MHz oscillator with ECL-level output. This oscillator was selected for its excellent short-term noise performance. The device does not have temperature compensation for long-term frequency drift. It is recommended that when performing phase noise measurements on the Q0420 PLO Evaluation System, a stable low noise external reference be used. The output from an HP8662B Signal Generator (back panel reference) provides an excellent 10 MHz reference for performing phase noise measurements.

4.3 LINE RECEIVER

In most synthesizer applications, phase noise performance is invariably a driving design requirement. The VCO and Reference Dividers are edge-triggered circuits. Random jitter on the input clock edges results in phase noise in the synthesizer output spectrum. Additive AM noise on the input reference signal can cause random jitter. The Reference Divider's sensitivity to this jitter can be decreased by ensuring that the input clock passes through the zero crossing threshold transition zone as quickly as possible. The line receiver performs this function by squaring up the edges of the input reference signal. We recommend using the on-board line receiver for input frequencies below 40 MHz if the input reference does not already have squared transitions.

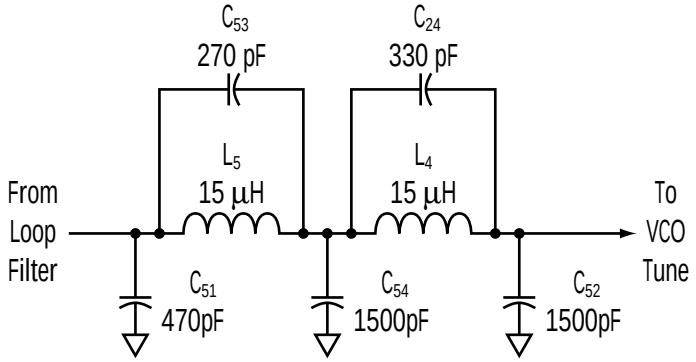
4.4 VOLTAGE CONTROLLED OSCILLATOR (VCO)

The Q0420 can accommodate two VCOs simultaneously. One VCO used on the Q0420 Evaluation Board has K_V = 95 MHz/V and a tuning range of 2000 - 3000 MHz. This high performance VCO helps demonstrate the low phase noise performance of PLO synthesizer systems designed around the QUALCOMM PLL device. The second VCO footprint is left unpopulated. Each VCO footprint accepts a pin-type or surface mount device.

4.5 LOOP FILTER

The differential phase detector outputs of the Q3236 are input to an active loop filter. The loop filter type is a modified loop filter with a pre-integrator. The loop filter was designed with a closed loop bandwidth of 100 kHz and a damping constant of 0.9. The values of the loop filter components were computed using the equations found in the *Q3236 Technical Data Sheet*. Appendix A lists component values.

Figure 12. Reference Suppression Filter



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
Q0420 Phase-Locked Oscillator (PLO) Evaluation System
User's Guide
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556
Data Subject to ChangeWithout Notice

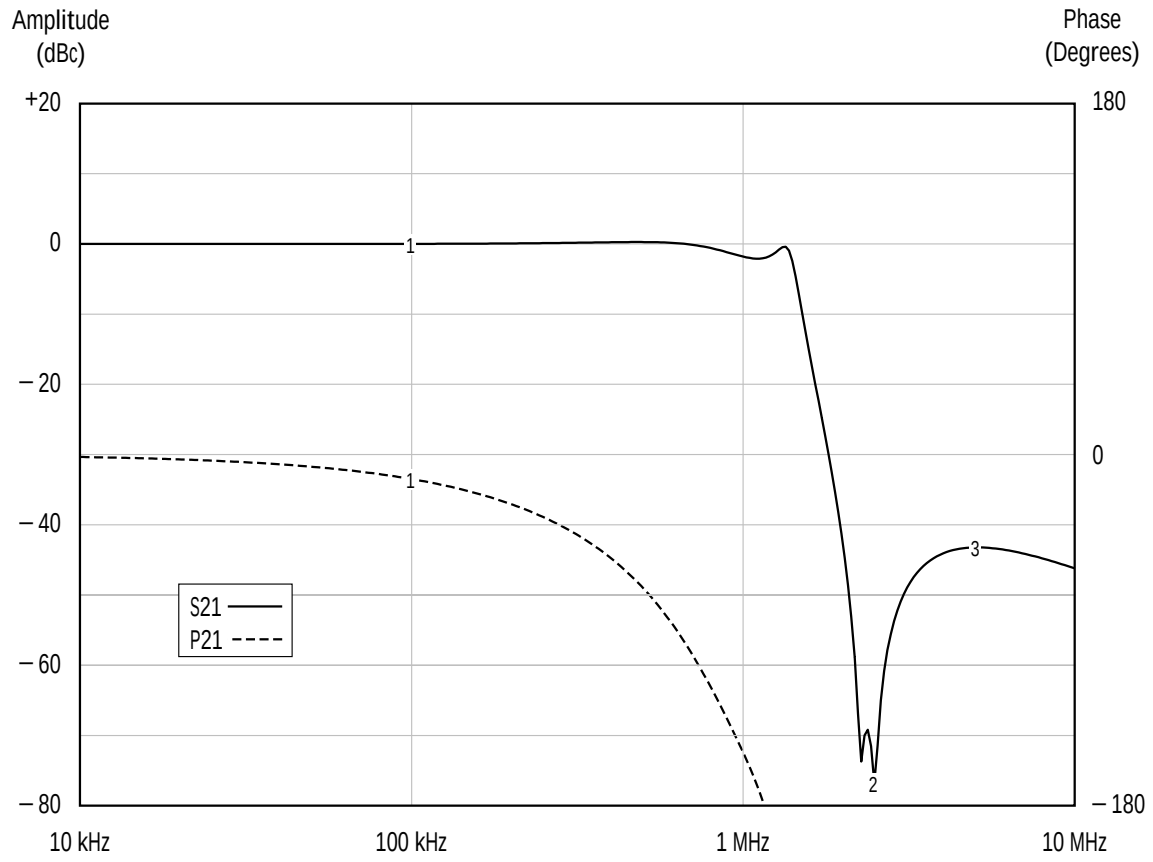
4.6 REFERENCE SUPPRESSION FILTER

The purpose of the Reference Suppression Filter is to attenuate undesired signals. A flip-flop type phase/frequency detector produces error pulses at F_{PD}. These pulses modulate the VCO and produce sidebands at FPD and at harmonics of F_{PD}. The Reference Suppression Filter is typically a low pass filter with fast transition times from passband to stopband (i.e., Elliptic Topology).

The Reference Suppression Filter designed for the Q0420 PLO Evaluation System is a five pole elliptical low pass filter. See Figure 12. The filter was designed to provide a wide "notch" at F_{PD} = 2.5 MHz, the Q0420 phase detector frequency. This design results in more than 70 dBc reference suppression for frequencies greater than 2.5 MHz, as seen in Figure 13.

Utilizing the five pole reference suppression filter, sideband spurs are suppressed to acceptable levels but the phase margin of the loop is also degraded. The Reference Suppression Filter on the Q0420 Evaluation Board degrades the phase margin by 12.5° at 100 kHz. Phase margin can be increased by designing narrower loop filters or by using a 3 pole elliptical filter. See the *Q3236 Technical Data Sheet*.

Figure 13. Reference Suppression Filter Graph



	100 kHZ (Marker 1)	2.5 MHZ (Marker 2)	5.0 MHZ (Marker 3)
AMPLITUDE	– .02	– 76.8	– 43.2
PHASE	– 12.5661	–	–

4.7 PRESCALER

The Q0420 provides a divide-by-2 prescaler in the feedback path. This allows frequencies greater than 2.0 GHz to be synthesized using the Q3236. This prescaler operates up to 3.0 GHz. With the installation of two 0 Ω resistors, the prescaler can be utilized or bypassed.

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

5.0 DESIGN HINTS AND SUGGESTIONS

5.1 POWER SUPPLIES

Passive filtering of the power supply inputs is provided on-board the Q0420. For optimal synthesizer performance, it is recommended that a clean voltage supply be used to supply power to the PLL device to eliminate any contributions of extraneous noise coupling through the power bus lines to the synthesizer's output.

5.2 EXTERNAL REFERENCE SOURCE

The external reference input is provided to enable you to use a PLL reference of your choice. This feature is important when performing low noise measurements or to have a reference source other than the on-board 40 MHz reference.

5.3 Q0420 EMI SHIELD

The Q0420 Evaluation Board comes complete with an EMI Circuit Card Assembly Shield. This shield was designed to reduce the effect of RF-coupling to the Q0420 PLO Evaluation System from typical lab RF emissions.

5.4 PHASE OFFSET TRIMPOT

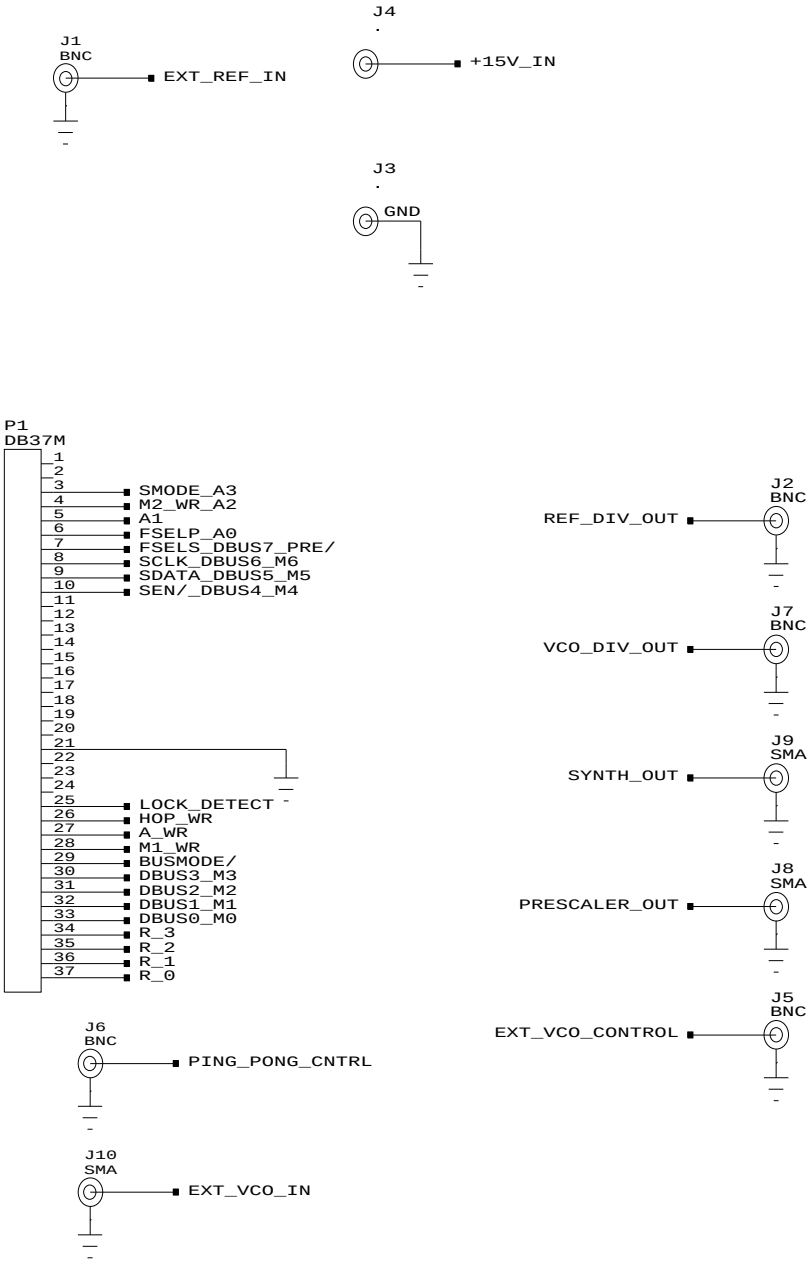
The Phase/Frequency Detector of the Q3236 is "linearized", i.e., there is no dead zone, due to the addition of a residual pulse onto both phase detector outputs. This situation can be exploited by a phase offset adjust circuit to optimize the comon-mode rejection of the phase detector output pulses as they are subtracted from one another in the differential active loop filter. The Q0420 introduces this phase offset by using the method described on page 37 of the *Q3236 Technical Data Sheet*. A trimpot (R51) is used to bias the phase detector outputs. The phase offset allows you to trade off between reference spurs and phase noise. The optimum phase offset allows the phase detector output (PD U OUT or PD D OUT) to reach its full amplitude. Typically a phase offset of 10 ns is sufficient and also allows for mismatches in temperature coefficients of the differential active loop filter.

6.0 RELATED LITERATURE

Q3236 2.0 GHz Low Power PLL Frequency Synthesizer Technical Data Sheet
Hybrid PLL/DDS Frequency Synthesizers, AN2334-4

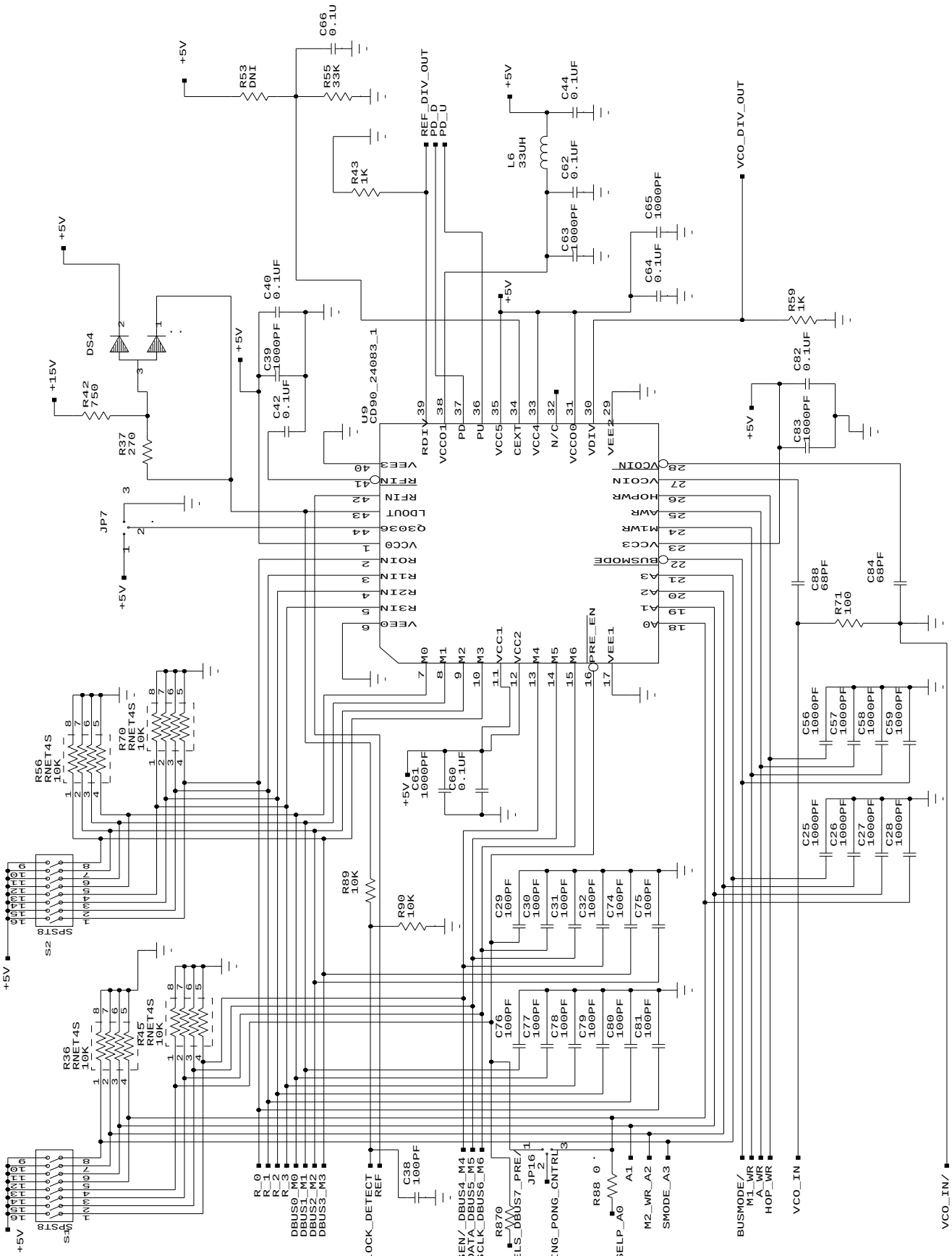
7.0 APPENDIX

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

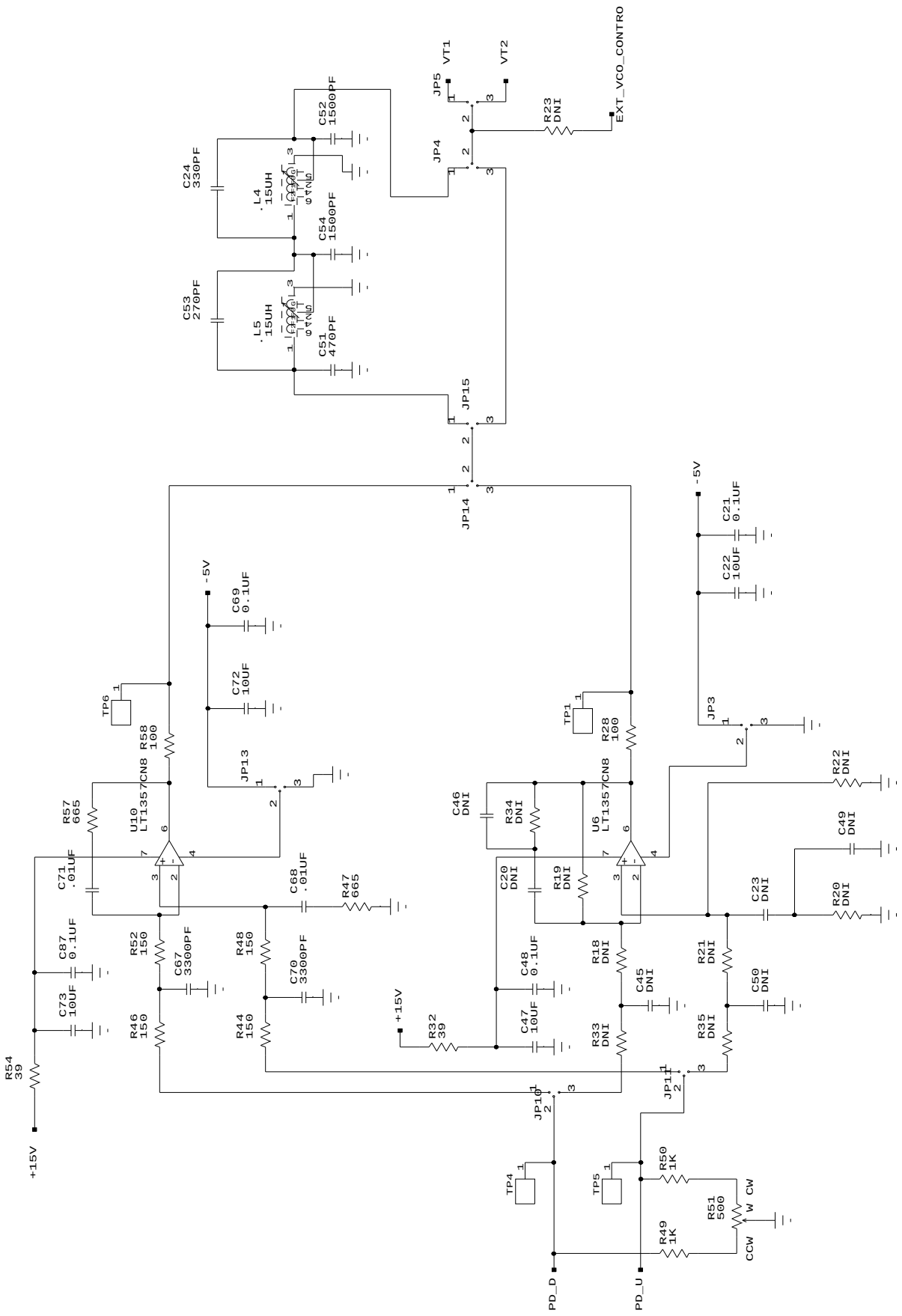


QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
Q0420 Phase-Locked Oscillator (PLO) Evaluation System
User's Guide

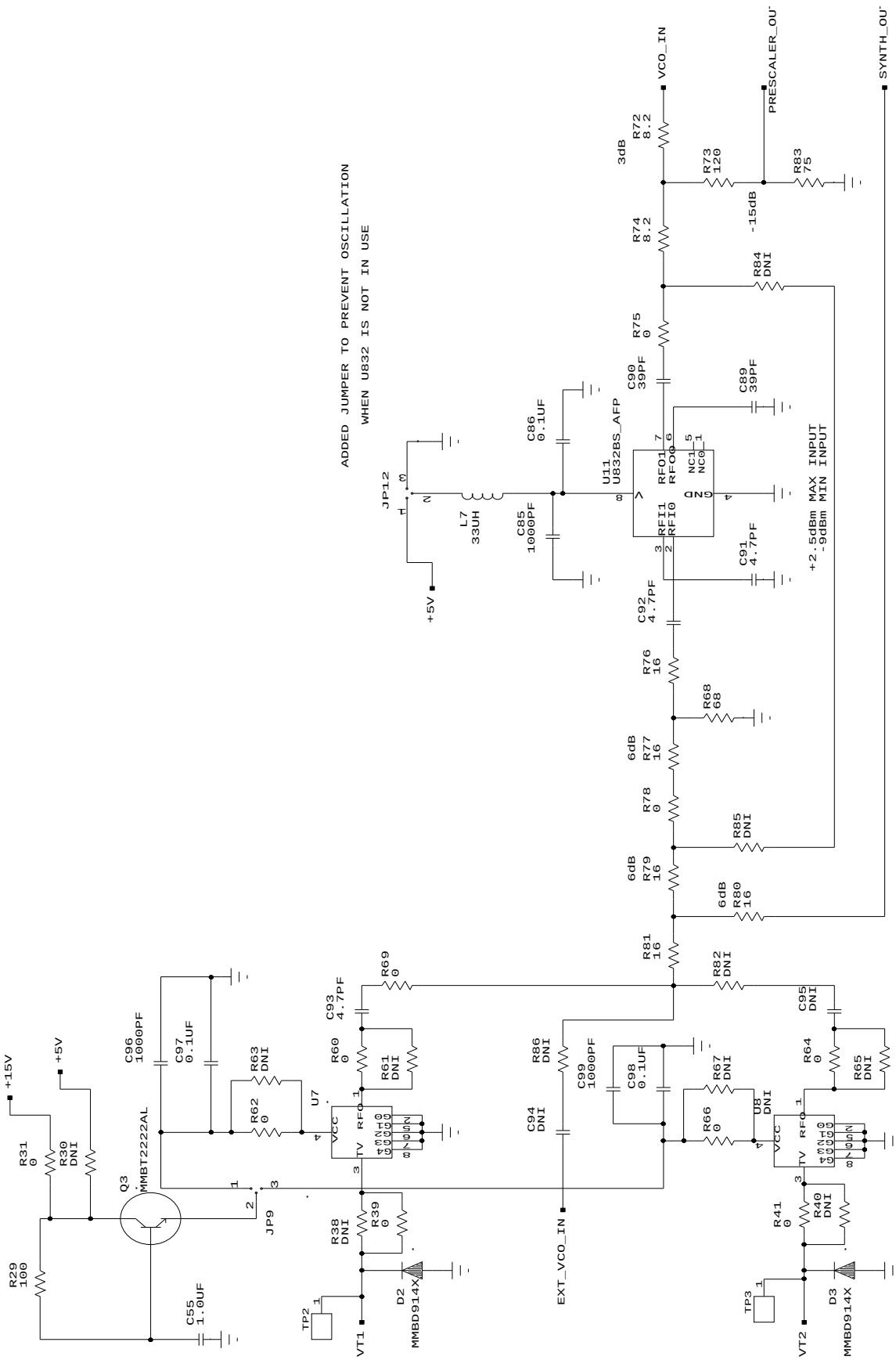
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556
Data Subject to ChangeWithout Notice



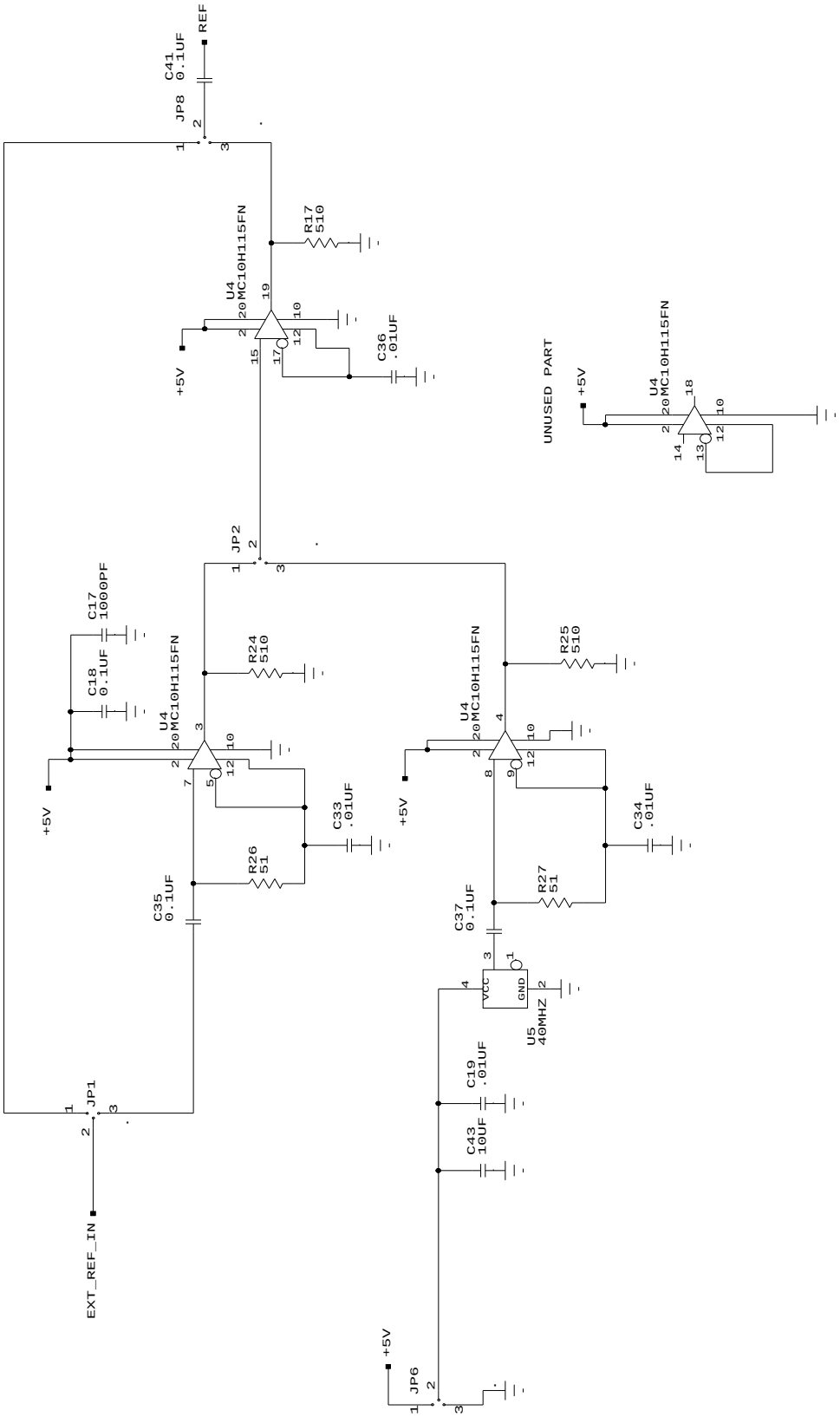
QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556



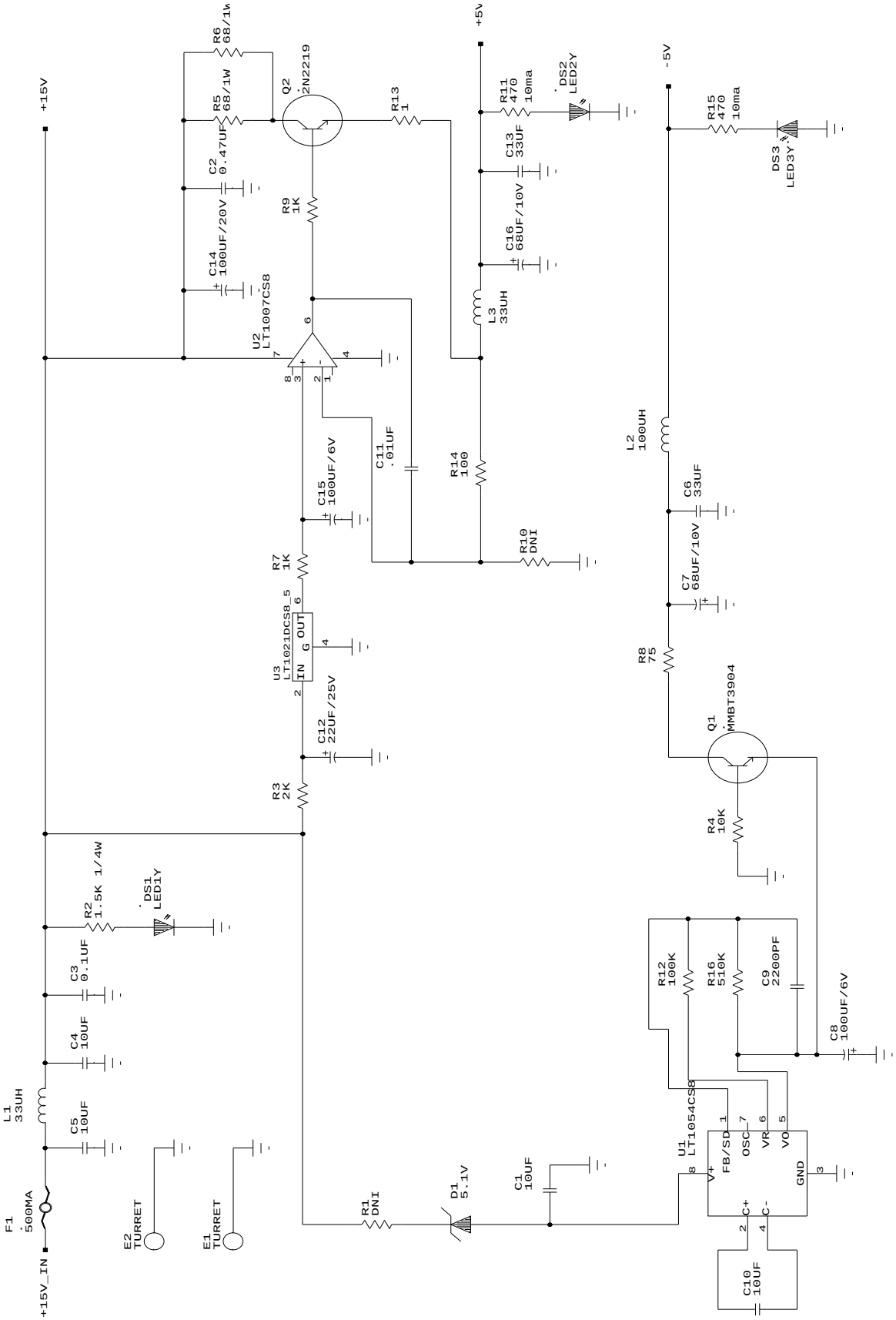
QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

7.2 APPENDIX B: Q0420 PARTS LIST

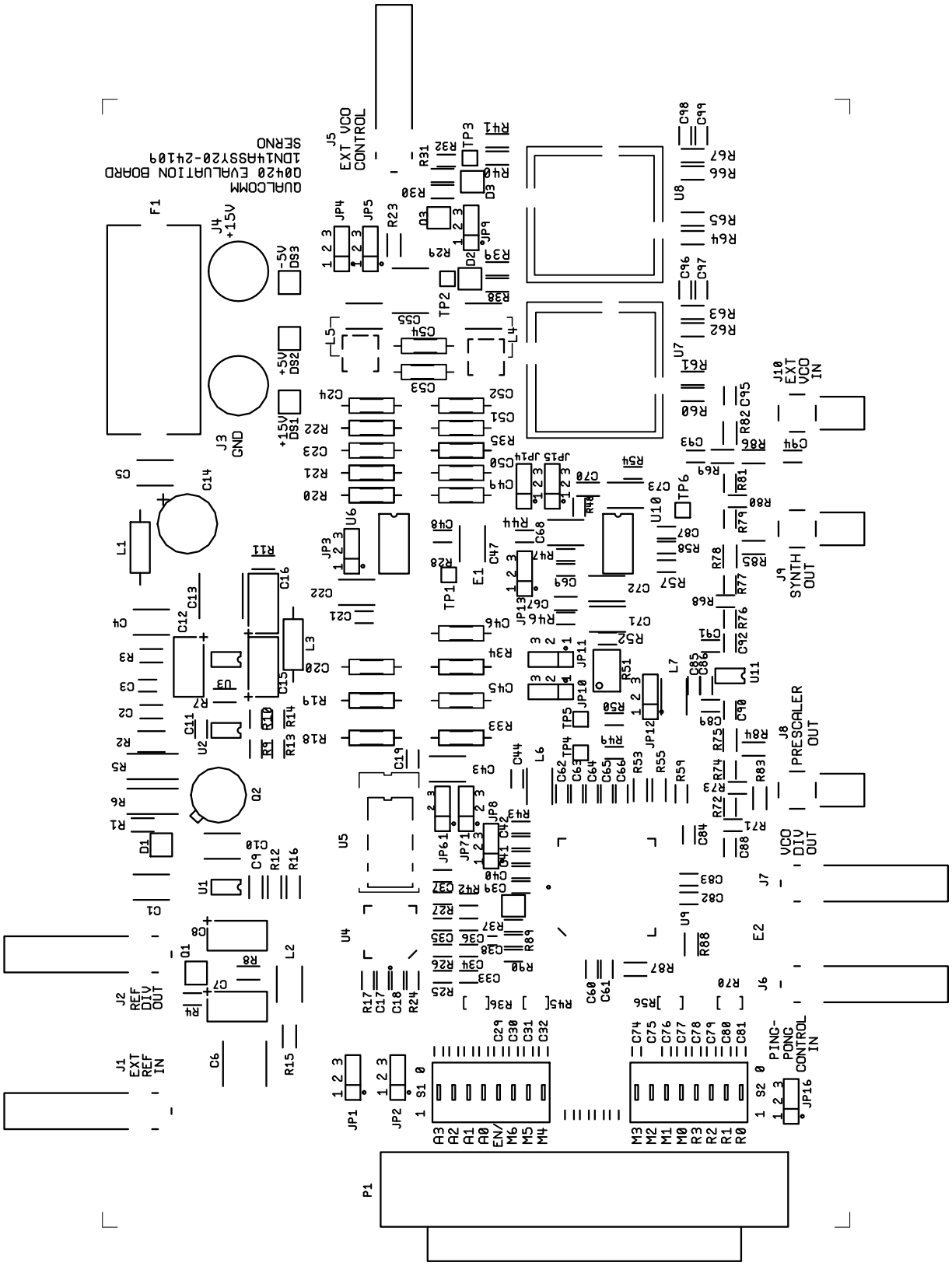
REFERENCE DESIGNATOR	QTY	QUALCOMM MCN	MANUFACTURERS PART NUMBER	PART DESCRIPTION
	1	25-24109-1	25-24109-1	PWB, Q0420, Eval Board
R31,R39,R41, R60,R62, R64, R66, R69, R75, R78, R87-R88	12	100-01011-0000	RM73Z2B000J	RES, Chip Thick Film Zero 5% 1/8W (Size 1206)
R7	1	100-01011-1001	RM73B2B102J	RES, Chip Thick Film 1.0K 5% 1/8W +/-200PPM/C
R12	1	100-01011-1003	RM73B2B104J	RES, Chip Thick Film 100K 5% 1/8W +/-200PPM/C
R3	1	100-01011-2001	RM73B2B202J	RES, Chip Thick Film 2.0K 5% 1/8W +/-200PPM/C
R55	1	100-01011-3302	9C12063A333JLR	RES, Chip Thick Film 33K 5% 1/8W +/-200PPM/C
R11,R15	2	100-01011-4700	RM73B2B471J	RES, Chip Thick Film 470 5% 1/8W +/-200PPM/C
R16	1	100-01011-5103	9C12063A514JLR	RES, Chip Thick Film 510K 5% 1/8W +/-200PPM/C
R8,R83	2	100-01011-75R0	9C12063A750JLR	RES, Chip Thick Film 75 5% 1/8W +/-200PPM/C
R2	1	100-01011-1501	CRCW1210-152J	RES, Chip Thick Film 1.5K 5% 1/4W +/-200PPM/C
R5-R6	2	100-02323-68R0	CRCW2512680J	RES, Chip Thick Film 68 5% 1W +/-200PPM/C
R14,R28-R29,R58,R71	5	100-06723-0101	RM73B2A101J	RES, Chip Thick Film 100 5%.1W +/-200PPM/C
R9,R43,R49-R50,R59	5	100-06723-0102	RM73B2A102J	RES, Chip Thick Film 1.0K 5%.1W +/-200 PPM/C
R4,R89-R90	3	100-06723-0103	RM73B2A103J	RES, Chip Thick Film 10K 5%.1W +/-200 PPM/C
R73	1	100-06723-0121	MCR10JW121	RES, Chip Thick Film 120 5%.1W +/-200 PPM/C
R76-R77,R79-R81	5	100-06723-0160	RM73B2A160J	RES, Chip Thick Film 16.0 5%.1W +/-200 PPM/C
R13	1	100-06723-01R0	MCR10JW1R0	RES, Chip Thick Film 1.0 5%.1W +/-200 PPM/C
R37	1	100-06723-0271	RM73B2A271J	RES, Chip Thick Film 270 5%.1W +/-200 PPM/C
R32,R54	2	100-06723-0390	CRCW0805-390J	RES, Chip Thick Film 39.0 5%.1W +/-200 PPM/C
R26-R27	2	100-06723-0510	RM73B2A510J	RES, Chip Thick Film 51.0 5%.1W +/-200 PPM/C
R17,R24-R25	3	100-06723-0511	RM73B2A511J	RES, Chip Thick Film 510 5%.1W +/-200 PPM/C
R68	1	100-06723-0680	RM73B2A680J	RES, Chip Thick Film 68.0 5%.1W +/-200 PPM/C
R42	1	100-06723-0751	RM73B2A751J	RES, Chip Thick Film 750 5%.1W +/-200 PPM/C
R72,R74	2	100-06723-08R2	MCR10JW8R2	RES, Chip Thick Film 8.2 5%.1W +/-200 PPM/C
R44,R46,R48,R52	4	100-06725-1500	MCR10FX1500	RES, Chip Thick Film 150 1%.1W +/-200 PPM/C
R47,R57	2	100-06725-6650	MCR10FX6650	RES, Chip Thick Film 665 1%.1W +/-200 PPM/C
R36,R45,R56,R70	4	101-08318-0103	EXBV8V103J	RES Chip Network, 10K 5% 12V 300PPM (4RES) Isolated
R51	1	102-01023-5000	3266W-1-501	RES, Variable 500 10% 1/4W 12 Turn 1/4" Sq
C89-C90	2	105-01073-0390	C0805C390J5GAC3	CAP, Chip Ceramic 39PF 5% COG/NPO 50V
C91-C93	3	105-01073-04R7	C0805C479D1GAC3	CAP, Chip Ceramic 4.7PF +/-.5PF COG/NPO 50V
C84,C88	2	105-01073-0680	C0805C680J5GAC	CAP, Chip Ceramic 68PF 5% COG/NPO 50V
C52,C54	2	105-01073-1152	C1206C152J5GACT	CAP, Chip Ceramic 1500PF 5% COG/NPO 50V
C9	1	105-01073-1222	1206C0222J2B04	CAP, Chip Ceramic 2200PF 5% COG/NPO 50V
C53	1	105-01073-1271	1206C0271J2B04	CAP, Chip Ceramic 270PF 5% COG/NPO 50V
C24	1	105-01073-1331	1206C0331J2B04	CAP, Chip Ceramic 330PF 5% COG/NPO 50V
C67,C70	2	105-01073-1332	VJ1206A332JXAM	CAP, Chip Ceramic 3300PF 5% COG/NPO 50V
C51	1	105-01073-1471	VJ1206A471JXBM	CAP, Chip Ceramic 470PF 5% COG/NPO 50V
C68,C71	2	105-01073-3103	VJ1812A103XAM	CAP, Chip Ceramic .01U F 5% COG/NPO 50V
C29-C32,38,C74-C81	13	105-01073-6101	VJ0603A101JXAA	CAP, Chip Ceramic 100PF 5% COG/NPO 50V
C25-C28,C56-C59	8	105-01247-6102	C0603C102K5RAC	CAP, Chip Ceramic 1000PF 10% X7R 50V
C17,C39,C61,C63,65C83,C85,C96,C99	9	105-01247-0102	500R15W0102KW2-	CAP, Chip Ceramic 1000PF 10% X7R 50V
C11,C19,C33-C34,C36	5	105-01247-0103	VJ0805Y103KXBM	CAP, Chip Ceramic .01UF 10% X7R 50V
C3,C18,C21,C35,C37,C40-C42,C44,C48, C60,C62,C64,C66,C69,C82,C86-C87, C97-C98	20	105-01249-0104	VJ0805U104MXA	CAP, Chip Ceramic .1UF 20% Z7U 50V

REFERENCE DESIGNATOR	QTY	QUALCOMM MCN	MANUFACTURERS PART NUMBER	PART DESCRIPTION
C55	1	105-01249-4105	VJ1825U105MXAM	CAP, Chip Ceramic 1.0 UF 20% Z5U 50V
C2	1	105-07324-0474	THCS30E1H474ZT	CAP, Chip Ceramic 0.47UF +80/-20% Y5U 50V
C1,C4-C5,C10,C22,C43,C47,C72-C73	9	105-07490-0106	THCS50E1E106ZT	CAP, Chip Ceramic 10UF +80/-20% Y5U 25V
	ALT	105-10035-0106	THCR50E1E106ZT	CAP, Chip Ceramic 10UF +80/-20% Y5U 25V
C6,C13	2	105-10016-0336	THCS70E1E336ZT	CAP, Chip Ceramic 33UF +80/-20% Y5U 25V
	ALT	105-10036-0336	THCR70E1E336ZT	CAP, Chip Ceramic 33UF +80/-20% Y5U 25V
C12	1	106-01067-0226	T491D226K025AS7	CAP,Chip Tant 22UF 10% 25V
C8,C15	2	106-02646-0107	T491D107K006AS	CAP,Chip Tant 100UF 10% 6V
C7,C16	2	106-02648-0686	T491D686K010AS	CAP,Chip Tant 68UF 10% 10V
C14	1	106-10018-0101	CACFM1D101M	CAP, Solid AL 100 UF +/-20% 20V Hi Freq
L2	1	110-02161-0104	IMC-1812-100UH	Inductor, Chip 100UH 10% Q=50 SRF=8.0MHz
L6-L7	2	110-02161-0333	IMC-1812-33UH+	Inductor, Chip 33UH 10% Q=50 SRF=11MHz
L1,L3	2	110-06324-0330	7130-19	Inductor, Mini Choke 33UH 10% High Current
L4-L5	2	111-05086-0150	614BN-9150Z	Inductor, VAR Shield 15UH
U7	1	137-06030-3018	M3500C-2032T	Oscillator, Voltage Controlled 2000-3200MHz
U5	1	137-08473-4000	SG-615PH 40.0MH	Oscillator, Crystal 40.0MHz +/-100PPM W/Enable
D2-D3	2	140-01263-0914	MMBD0914LT1	Diode, Switching General Purpose
D1	1	141-01260-05R1	PMBZ5231B	Diode, Zener 5.1V 5% 225MW
Q3	1	160-01028-2222	MMBT2222	Transistor, NPN HFE=10V At VCE=10V IC=150MA
Q1	1	160-01028-3904	MMBT3904	Transistor, NPN HFE=10V At VCE=1V IC=10MA
Q2	1	162-10017-2219	2N2219A	Transistor, General Purpose
U4	1	211-02623-0115	MC10H115FN	IC, 10KH Ecl Quad Line Receiver
U1	1	281-02268-1003	LT1054CS8	IC, Voltage Converter Switched Capacitor W/Reg
U3	1	281-10014-0000	LT1021DCS8-5	IC, Voltage Reference Precision 5.0V +/-20PPM/C
U2	1	281-10015-0000	LT1007CS8	IC, Operational Amp Precision High Speed Low Noise
U6,U10	2	281-10019-0000	LT1357CN8	IC, Operational Amp High Speed High Slew Rate
U11	1	284-08150-0003	U832BS-AFP	IC, Prescaler Div By 2 3.0GHz
S1-S2	2	304-01668-0001	78RB08S	Switch, Dip SPST 8-Pos Slide Recessed
DS1-DS3	3	310-06441-1001	LYS260DOE7502	LED, High-Efficiency Diffused Yellow
DS4	1	310-06441-1003	LUS250DOE7502	LED, High-Efficiency Diffused Red/Green
F1	1	326-07302-0000	354 101-GY	Fuseholder, PCB MT Single Pole 3AG Fuse
E1-E2	2	446-06598-0000	160-1558-02-01-	Terminal, Solder Turret Silver .062" PCB
TP1-TP6	6	449-01086-0001	TSW-101-07-L-S	Conn, Strip Header .025SQ 1X1 POS PCB .230 AU/SN
JP1-JP16	16	449-01086-0003	TSW-103-07-L-S	Conn, Strip Header .025SQ 1X3 POS PCB .230 AU/SN
J4	1	470-01902-0001	111-0702-001	Conn, Banana Plug/Binding Post No Term Red
J3	1	470-01902-0002	111-0703-001	Conn, Banana Plug/Binding Post No Term Black
P1	1	474-02449-0037	747252-4	Conn, D-Sub R/A PCB Metal Shell 37-POS
J8-J10	3	480-01064-0057	85SMA50-0-44	Conn, SMA R/A PCB Female Receptacle
J1-J2,J5-J7	5	480-01453-0022	413631-1	Conn, BNC Jack R/A PC Mount 500HM
U9	1	CD90-24083-1	CD90-24083-1	IC, PLL2, Frequency Synthesizer, Com'l
	2	500-01350-0308	SMO-8-S6T	Socket, IC 8-Pin .3MIL PCB Mach. Screw AU Contact
	1	500-02488-0044	PLCC-44-SMT-TT	Socket, IC PLCC 44-Pin SMT Low-Profile No POL-PEG
	1	325-06847-0050	AGC-1/2	Fuse, N America 1/2A 1/4X1-1/4 Fast/No Delay
	1	520-01805-0011	2226B	Heatsink, TO-5 D=.75" Press-On
	16	448-01403-0000	MSB-2360-100-AU	Jumper, Terminal Bi-Pin

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

7.3 APPENDIX C: Q0420 LAYOUT DRAWINGS

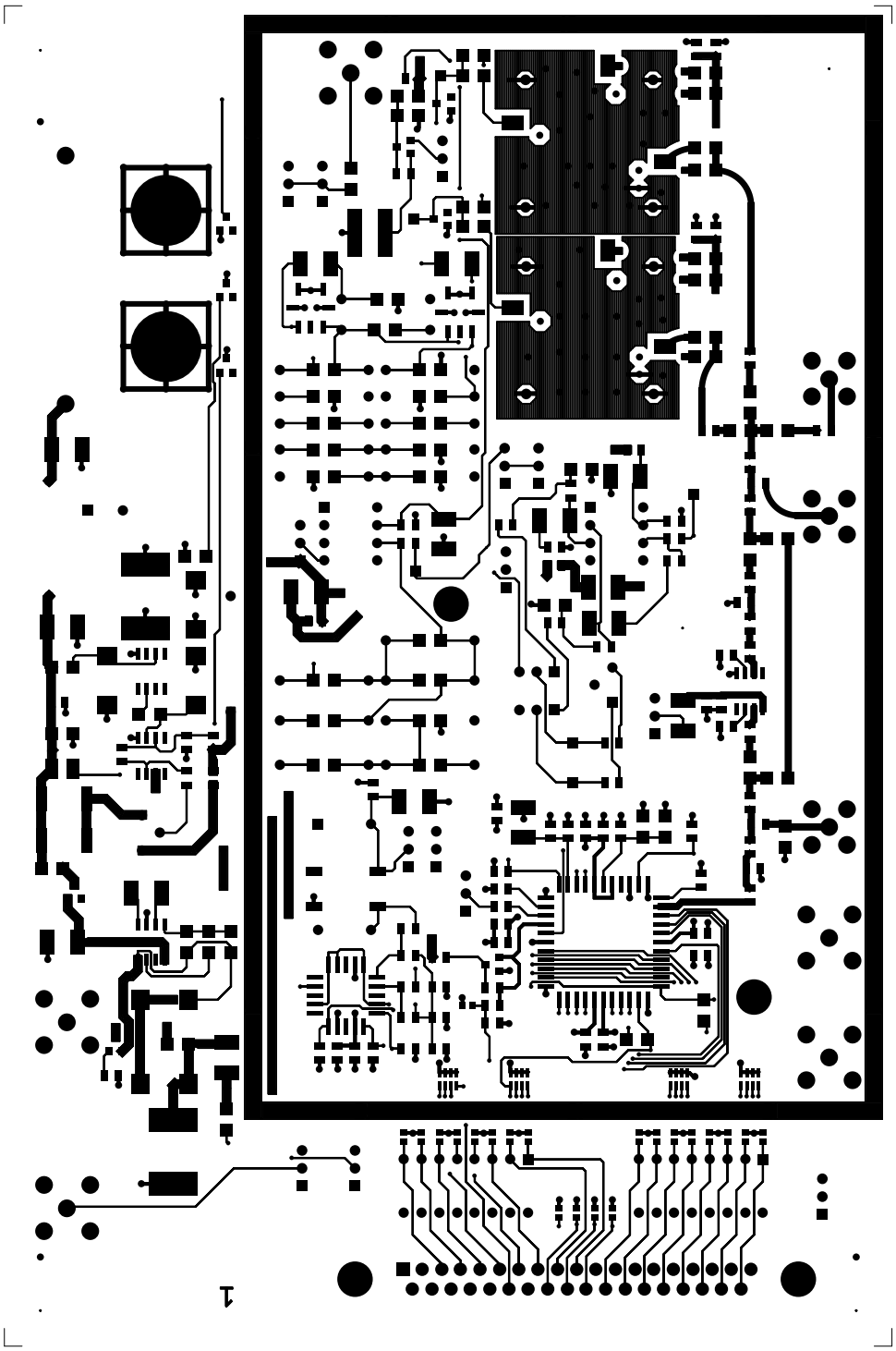
Q0420 Evaluation Board "Top Silk"



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
Q0420 Phase-Locked Oscillator (PLO) Evaluation System
User's Guide

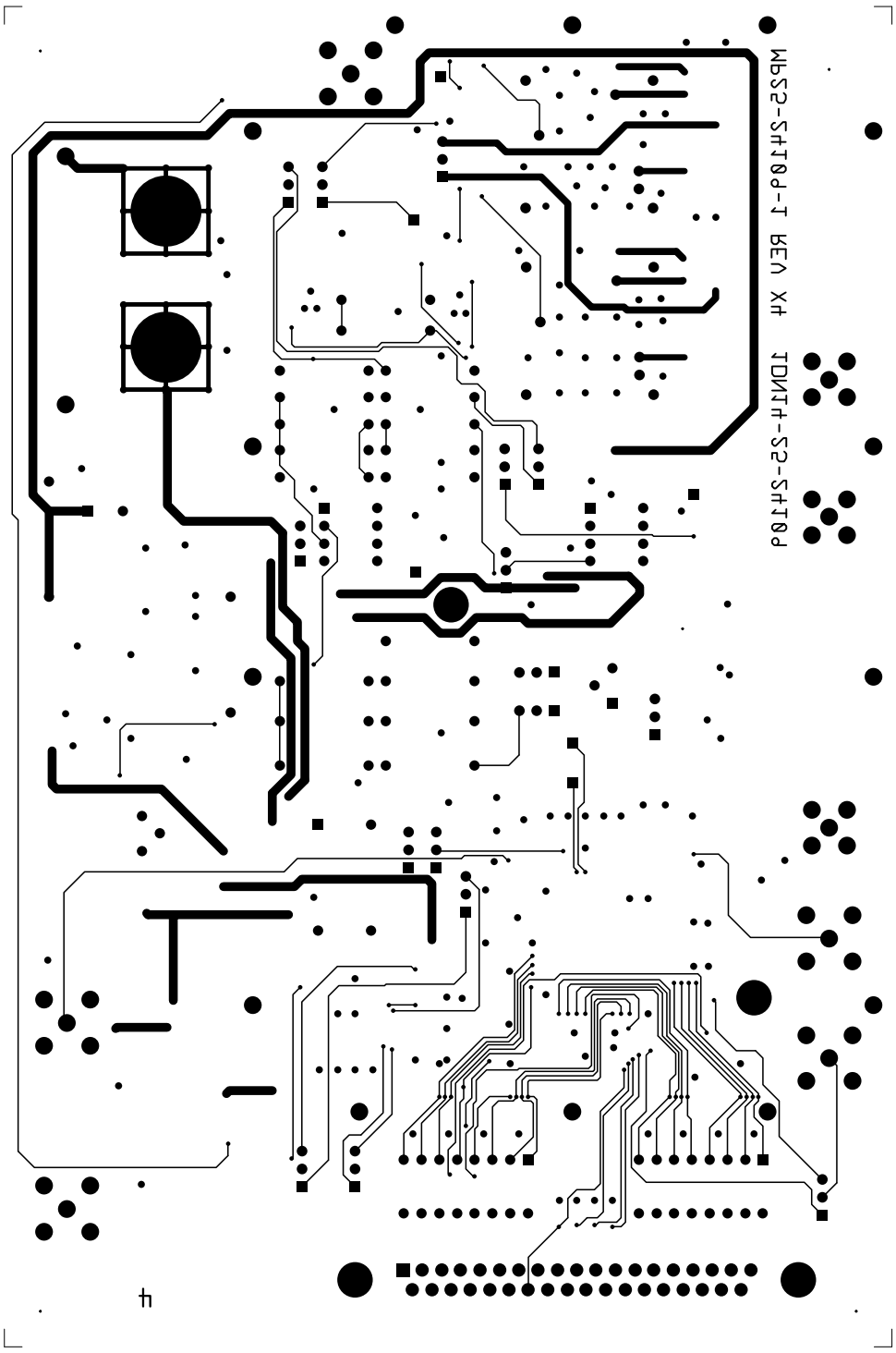
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556
Data Subject to ChangeWithout Notice

Q0420 Evaluation Board "Top Traces"



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

Q0420 Evaluation Board "Bottom Traces"



QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
Q0420 Phase-Locked Oscillator (PLO) Evaluation System
User's Guide

E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556
Data Subject to ChangeWithout Notice

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

QUALCOMM ASIC PRODUCTS

PRODUCT #	NAME	DESCRIPTION
Q2368	Dual Direct Digital Synthesizer (DDS)	130 MHz / 65 MHz
Q2240	Direct Digital Synthesizer (DDS)	100 MHz
Q2334	Dual Direct Digital Synthesizer (DDS)	50 MHz / 20 MHz
Q2220	Direct Digital Synthesizer (DDS)	50 MHz
Q3236	Phase-Locked Loop (PLL) Frequency Synthesizer	2.0 GHz
Q0310	DDS Evaluation Board	Evaluation of Q2334
Q0320	DDS Evaluation Board	Evaluation of Q2220
Q0420	PLO Evaluation System	Evaluation of Q3236
Q0710	DDS-Driven PLL Frequency Synthesizer	Evaluation of Q2334 & Q3236
Q0256	Viterbi Decoder	256 kbps
Q1650	Viterbi Decoder	25 Mbps, 10 Mbps, 2.5 Mbps
Q1875	Trellis Codec	75 Mbps, 30 Mbps
Q4413	Vocoder	13.3 kbps
Q4401	Vocoder	8 kbps
Q0810	Vocoder Evaluation Board	Evaluation of Q4401
Q0820	Vocoder Evaluation System	Evaluation of Q4401
Q5500	Receive Automatic Gain Control Amplifier	300 MHz
Q5505	Transmit Automatic Gain Control Amplifier	300 MHz
Q5270	Mobile Station Modem (MSM2.2)	For CDMA Subscriber Unit
Q5312	Analog Baseband Processor (BBA2)	For CDMA Subscriber Unit
Q5160	Cell Site Modem (CSM)	For CDMA Base Station

- Data books, application notes and user's guides are available for detailed design information.

Q0420 Phase-Locked Oscillator (PLO) Evaluation System User's Guide
Data Subject to Change Without Notice
For customer service or technical assistance, please contact:

QUALCOMM Incorporated, ASIC Products
6455 Lusk Boulevard, San Diego, CA 92121-2779, USA
E-mail: asic-products@qualcomm.com
Telephone: (619) 658-5005
Fax: (619) 658-1556

80-24112-1
7/96